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INDUSTRIAL DEPRESSIONS AND THE PIG-IRON RESERVE.

By George H. Hull.

THE first requisite for a successful study of this subject is a clear appreciation of the difference between *industrial depressions* and *financial panics.* The former result from an abnormal advance in the price of the great staples of the country, principally those used in the building of houses, railroads, and such other works as are usually classed under the head of permanent improvements. When these staples advance in price as much as 80 to 100 per cent. above their normal market value, a large percentage of the building enterprises of the country are stopped. This throws a vast army of workers out of employment, and causes a heavy decline in the market value of all materials used in these improvements. If this decline in value be equal to the preceding advance, it results in such enormous losses that a financial panic is the almost certain result.

In brief, industrial depressions are the effects of great advances in prices; financial panics are the effects of great falls in prices.

A financial panic is an acute mental malady. Its beginning is sudden, intense, and startling. Its chief element is fright. It paralyzes finances at a single blow, each subsequent step in its course being an alleviation. From its nature, it is short-lived.

Mr. Hull, writing in the *North American Review* in July, 1899, pointed out that the great advance in pig iron, which was then near its maximum, was simply a repetition of what had occurred in 1854, 1864, 1872, 1880, and 1889. And in every one of these cases, the reaction of a severe depression followed swiftly. "It was not disturbed finances nor loss of confidence which turned the tide of prosperity. It was the advance of from one hundred to three hundred per cent. in the price of pig iron. The loss of confidence and disturbed finances came months afterwards and were the effects of the turn of the tide."

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An industrial depression is a stubborn physical malady. Its beginning is so gradual and quiet that it may go on increasing for months unnoticed. From its nature, it is long-lived. It begins when everything is at the height of prosperity. Let me give a local and recent illustration.

In the little community in which I reside, there were twenty-three houses built in 1899, all of which were contracted for before the advance in prices. This kept the workers employed all the year. A large number of residences were planned for 1900, but when the bids for these came in, it was found that a residence which would have cost $100,000 in 1899 would cost $160,000 in 1900. The result has been that as bids have come in the projected buildings have been given up; and, as the houses contracted for at low prices have been completed, the workmen have departed. If this be an isolated instance and these workmen are finding employment elsewhere, then it signifies little. But if this be typical of what has been taking place throughout the country, and they are not finding other employment, then we have already made several months' progress towards industrial depression.

It is estimated that in the United States there were twenty-eight millions of persons engaged in some gainful occupation in 1899. The discharge of five out of each twenty-eight would hardly be noticed in

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The progress of affairs in the year since that was written has made the case still clearer, and in the accompanying article Mr. Hull has so sustained his argument with statistical evidence that it can not fail to be impressive and, we earnestly hope, will be productive of lasting good.

Iron, as Mr. Hull has pointed out, "enters more thoroughly into all business advances and improvements than any other article." It is the very substance of most of the great material creations of modern industry, and the substance of the necessary tools and machinery engaged in producing almost all other wealth. "Its consumption is a correct measure of the wealth and civilization of any people." For "the wealth of a people consists of the accumulation of what their labor has taken from the earth and fashioned into useful and marketable articles and commodities."

"With every able-bodied man employed, wealth is rapidly and steadily accumulated; every man has some surplus for the comforts and material possessions, as well as for the necessities of life; and every man is adding to his property and to the wealth of the nation." This "is the natural condition of an industrious people; it is, in effect, simply the whole people at work, consuming what they need from day to day and accumulating the surplus results of their labor in the form of permanent possessions."

"Whatever restricts the consumption of iron"—the fundamental material *with* which all must work and *upon* which a vast proportion of the total number of producers are working—"whatever restricts the consumption of iron, limits to that extent the growth of the people in wealth and prosperity." And such limitation, Mr. Hull shows most strikingly, has repeatedly been imposed by the enormous advance in the price of iron under every unusual demand—an advance so great that it is prohibitive to enterprise. The cause he finds plainly to be seen in insufficient reserve supply and inelasticity of production. "Every great staple, except iron, is either carried in large quantities or its output can be increased to any desired degree at short notice." Iron, however, is singularly lacking in either means of regulation. "No sane man would build an engine without a governor . . . and yet the most important interest of the country is without such a regulator." It is obvious that if the world depended on a three-weeks' reserve of provisions, famine would be a constant menace and a frequent happening. The vast industries dependent on iron are in a similar state of constant danger and of recurring famines, with their attendant exhaustion and painfully slow recovery.

The times emphasize Mr. Hull's grave warnings. It rests largely with the great iron workers of the world, by wisdom and foresight, to avert a disastrous depression following the advance of 1899; as depression followed the seven preceding advances of the last seventy-five years.—THE EDITORS.

any community, large or small, and yet, as soon as this takes place in each community, it amounts to a reduction of three thousand millions of dollars per annum in the buying power of the nation. This is not all. Fewer working hours and reduced wages must be accepted by those still at work. This takes other thousands of millions per annum from the buying power of the nation. No other suggested cause of industrial depressions compares with this in amount, or in its blighting effect upon the industries of a people.

The conditions of industrial depression are, first, discharge of workers, and just in proportion as this takes place the earnings of the people are reduced. This, in turn, cuts down expenditures and lessens demand. As demand falls off, production is cut down and more workers are discharged. Thus the five elements of depression—reduction of employment, of earnings, of expenditures, of demand, and of production form an endless chain, each acting directly upon and diminishing the other, each feeding upon and intensifying the other. The restoration to normal conditions comes only after a lapse of years. It comes finally simply because the natural condition of an industrious people is to be at work. The worker who is thrown out of a place immediately tries to find other employment. He wishes to earn, that he may buy. When all cannot find employment, it is because there is something wrong with the industrial system. When a minimum number are employed, they earn barely enough to supply the daily needs of all, and there is no increase in wealth. When all workers are employed in some gainful occupation, their earnings are so enormous that they not only absorb everything that is produced, but there is an immense surplus which goes largely into permanent improvements, increasing the personal possessions of the individual and the wealth of the nation. This is legitimate prosperity and cannot be overdone. There is a safe limit, and this is reached when all the workers are employed.

The earnings of the twenty-two millions of workers in the United States in 1890 are estimated at thirteen and a half billion dollars, and this does not include incomes from investments. (See Table A). The net products of all industries, including farms, manufactories, mines, quarries, fisheries, etc., are estimated at something over seven billions. No accurate figures are obtainable, but these estimates are on the census of 1890 and are sufficiently accurate to illustrate the fact that there can be no over-production when all workers are employed. So long as natural conditions have unbroken sway, there is no interruption to this vigorous and healthy condition of industries.

PERCENTAGE OF ALL PERSONS ENGAGED IN GAINFUL OCCUPATIONS IN THE UNITED STATES BY CLASSES AND GROUPS.

		1870.	1880.	1890.
GROUP A.	Bankers, brokers, manufacturers, merchants, proprietary farmers, professional pursuits, agents, commercial travelers, book-keepers, clerks, salesmen, etc.....	34.16	35.96	38.87
GROUP B.	Mechanical trades, clothing makers, metal, wood, leather and textile workers, steam railroad employees, food preparers, etc.....	20.33	20.72	24.10
GROUP C.	Agricultural laborers, servants, general laborers, miners, quarrymen, draymen, hostlers, street railroad employees, etc.....	45.51	43.32	37.03
		100.00	100.00	100.00
Whole number engaged in gainful occupations.....		12,505,923	17,392,099	22,735,661
Estimated earnings at the average of $600 per annum.....		$7,503,553,800	$10,435,259,400	$13,641,396,600
Gross product of all industries including farms, manufactories, quarries, mines, fisheries, etc.....		6,843,559,616	7,551,732,385	12,148,380,626
Amount paid for materials by the manufacturers (supposed to be previously reported).....		.....	.....	5,021 453,326
Estimated net products of all industries.....		.....	.....	$7,126,927,300
True wealth of the United States.....		$30,068,518,507	$43,642,000,000	$65,037,091,197

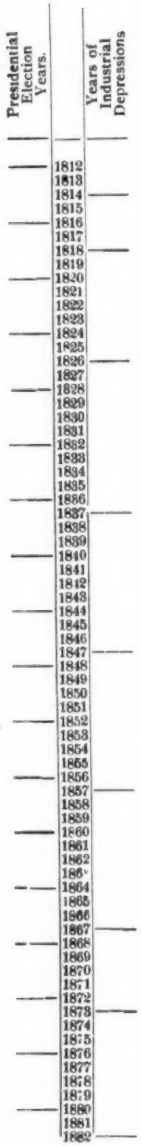
The people consume what they need, from day to day, and pile up the surplus products of their labor in permanent possessions. It is during such periods that the nations of the earth have accumulated their billions of permanent wealth.

To find the cause of these stupendous national calamities, which amount to a reduction of thousands of millions in the earnings of the people and which develop and creep over a whole country almost unnoticed, is the most important question of the present day.

For the solution of this question, the United States Congress appointed three commissions between 1882 and 1886. Like commissions have, in recent years, been appointed by Great Britain, France, Germany, Italy, Canada, and Belgium. Thousands of witnesses testified before these commissions. Their opinions fill volumes, and have been classified under one hundred and eighty different heads. Opinions are the most unreliable of all testimony. They are as varied as the countenances of the people who advance them. The prevailing opinion is often on one side of a question in one country and on directly the opposite side in another. Is it surprising, then, that the substance of all these government reports is that the cause of industrial depressions is still an unsolved mystery?

It is the tendency of the human mind to attribute industrial depressions to financial panics and other surface indications—especially to such causes as are most apparent to each from his individual standpoint. All see the froth and foam which ride on the crest of the wave, but few think of the strong unseen undercurrent which really disturbs the surface. A most striking confirmation of the prevalence of this tendency is found in the evidence of the thousands of witnesses who testified before these government commissions.

The banker cites reasons connected with finance; the laborer cites reasons connected with wages, or with the relations of capital to labor; the merchant cites reasons connected with tariff, transportation, competition, and the like. The clergyman and moralist cite reasons connected with morals and religion. The manufacturer thinks depressions come from over-production, and the politician believes that industrial depressions come from changes of administration, bad laws, etc. The English farmer thinks they come from free admittance to that country of foreign agricultural products. A Dutch committee in 1886 found an important cause in the low price of German vinegar —a German committee, in the great decline in the price of beet-root sugar. None of these touch upon the powerful primary cause. All are surface indications. All are mere opinions. Opinions are not



evidence. They prove nothing, and would not solve this question in another hundred years.

Many people in America have attributed industrial depressions in the past to "Presidential Elections." This can best be analyzed by the accompanying diagram. The intervals between industrial depressions have been four, eight, eleven, ten, ten, ten, six, and nine years, as against four-year intervals between elections. Three times depressions have come one year after elections, twice they have come one year before, and four times they have come half-way between. The only noticeable fact revealed by the diagram is that they have never come on the same year, although there is no logical reason why they should not.

Another alleged cause of industrial depressions is large transfers of money from one country to another. These are simple exchanges of value. Each party voluntarily parts with a value, to secure something considered of more value. Such exchanges help business. They are business—they do not cause depression. The largest transfer of money in modern times was the payment of the war indemnity by France to Germany in 1871 to 1873, and this was without any return of value. If such things brought industrial depression, then France should have been the first to suffer, whereas the depression of 1873 came to Germany several months before it appeared in France. This result was perfectly logical. The 5,500,000,000 francs poured into Germany stimulated her industries to a wonderful degree. The building of factories and other permanent improvements was unprecedented, the price of iron advanced enormously, followed by that of all other building materials. This abnormal advance stopped these improvements, threw large armies of workers out of employment, and industrial depression followed. The war indemnity hastened and intensified the great advance in prices in Germany, hence she was first to experience the logical result.

The large exportation of gold and large importation of goods has often been held responsible for industrial depressions in the United States. If this were

ever the cause, there would have been unusual prosperity in Great Britain and the continental countries which reaped the benefit of American extravagance, but such has never been the case. Those countries suffered depressions when the United States did.

The most exact and searching of all sciences is analysis. By its aid we may determine the composition of the heavenly bodies. Let us turn the science of analysis upon this subject.

The United States Commissioner of Labor, in his first annual report of Industrial Depressions, issued in 1886, gives some data, from analysis of the information gathered, which are of great value. First in importance is the conclusion that industrial depressions were most severe in Great Britain, United States, Germany, France, and Belgium, and were not felt to any material extent in other nations. Second, that the degree of severity in these five nations as related to each other was in the order named—that is, most severe in Great Britain, and so on. Third, that industrial depressions were nearly or quite contemporaneous in these five nations. The following paragraph and table is taken from page 290 of said report:

"It has been clearly shown that the depressions of the past in the manufacturing nations of the world have been nearly or quite contemporaneous in their occurrence. Summarized as to dates, the following table is deduced":

TABLE B.

Countries.	Years of Depressions.											
United States..	——	——	1814	1818	1826	——	1837	1847	1857	1867	1873	1882
Great Britain..	1803	1810	1815	1818	1826	1830	1837	1847	1857	1866	1873	1883
France	1804	1810	1813	1818	1826	1830	1837	1847	1856	1866	1873	1882
Belgium	——	——	——	——	——	——	1837	1848	1855	1864	1873	1882
Germany	——	——	——	——	——	——	1837	1847	1855	——	1873	1882

In seeking the cause of industrial depressions, therefore, we may clear the field of a large amount of rubbish by summarily dismissing from the investigation, as untenable, all alleged causes which are purely local in a national sense, such as presidential elections, changes in tariff, demonetization of silver, national banking system, etc.

We must look for the real cause in some condition which was common to the five nations and which did not exist in the other nations, or in something which took place in the five nations contemporaneously and did not take place in the other nations. We must find, also, some cause which placed the five nations in the order they occupied as to relative severity of industrial depressions, and, finally, some cause which grouped little Belgium with the larger nations, Great

Britain, United States, Germany, and France, while Russia, Austria, Italy, and Spain were grouped with the smaller nations.

In the following table, which gives the world's iron production, will be found conditions which meet in every particular the requirements just defined. The record of production in 1882 and 1886 is given, because that was the period covered by the various government investigations which discovered the relative severity of past panics.

TABLE C. PRODUCTION OF IRON IN THE LEADING INDUSTRIAL COUNTRIES.

	1882. Tons.	1886. Tons.
Great Britain	8,586,680	7,009,754
United States	4,623,323	5,683,329
Germany and Luxemburg	3,380,805	3,528,657
France	2,039,067	1,516,574
Belgium	726,946	701,677

On the other hand, a careful search through the 800 pages of Mulhall's Dictionary of Statistics fails to reveal any matter connected with Finance, Agriculture, Manufacture, Earnings, Expenditures, or Trade, which answers these requirements. There is, in fact, no matter aside from iron production which even places the five countries in one group, to say nothing of placing them in the order they occupy as to severity of industrial depressions.

Before iron became of preponderating importance to the industries of nations, there were no industrial depressions except those born of causes apparent at the time, such as pestilence, famine, and war. The condition of industries in the United States up to 1814 was one of uninterrupted prosperity. France and Great Britain, which then furnished the world's iron supply, experienced two seasons of industrial depression during this period. The United States was the next country to produce sufficient iron to give it importance in the economics of the nation. Later on Germany and Belgium became large producers, and just in this order they commenced to experience industrial depressions. Table B, page 647, reflects these facts.

Iron is acknowledged to be the foundation on which the modern industrial system rests. If that system is disturbed, it is most natural to look to the foundation for the cause of the disturbance. If one would appreciate how thoroughly the entire industrial system depends upon iron, let him imagine what the world would be to-day without it —what it would be if we depended upon wood, stone, copper, and tin for our implements of agriculture, tools, machinery, vehicles of trans-

LOWEST AND HIGHEST PRICES OF SCOTCH PIG IRON IN NEW YORK FROM 1825 TO 1882, FROM THE AMERICAN ALMANAC.

EDITED BY AINSWORTH R SPOFFORD, LIBRARIAN OF CONGRESS.

			Lowest.	Highest.	Year.	
Low,	High,	Depression.	**35.**	**75.**	1825	114 per cent. advance.
			50.	70.	**1826**	
			50.	55.	1827	
			50.	55.	1828	
			40.	55.	1829	
			40.	50.	1830	
			40.	47.50	1831	
			40.	47.50	1832	
			37 50	47.50	1833	
Low,			**37.50**	48.	1834	
			38.	42.50	1835	
	High,	Depression.	38.	**62.50**	1836	
			40.	**70.**	**1837**	86 per cent. advance.
			37.50	55.	1838	
			37.50	45.	1839	
			32.50	40.	1840	
			32.	37.50	1841	
			23.50	35.	1842	
Low,			**22.50**	32.	1843	
			30.	35.	1844	
	High,		30.	**52 50**	1845	133 per cent. advance.
			35.	42.50	1846	
		Depression.	30.	42.50	**1847**	
			25.	37.50	1848	
			22.50	27 50	1849	
			21.	24.	1850	
			19.	25.	1851	
Low,			**19.**	31.	1852	
			28.50	38.	1853	
	High,		32.	**42.50**	1854	123 per cent. advance.
			26.50	37.	1855	
			29.	37.	1856	
		Depression.	28.	37.50	**1857**	
			22.	27.	1858	
			22.	31.50	1859	
			20.50	27.	1860	
Low,			**20.**	24.50	1861	
			21.	33.	1862	
			32.50	45.	1863	
	High,		43.	**80.**	1864	300 per cent. advance.
			40.	55.	1865	(Depreciated currency.)
			42.	55.	1866	
		Depression.	38.	49.	**1867**	
			35.	45.75	1868	
			34.50	45.	1869	
			31.	37.	1870	
Low,			**30.**	39.	1871	
	High,		33.50	**61.**	1872	103 per cent. advance.
		Depression.	37.	52.	**1873**	
			33.	45.	1874	
			29.	41.	1875	
			27.50	34.	1876	
			25.	28.	1877	
			21.50	26.50	1878	
Low,			**19.**	30.50	1879	
	High,		21.	**35.**	1880	84 per cent. advance.
			22.	26.	1881	
		Depression.	23.	26.50	**1882**	

portation on land and sea, the vast network of rails on the surface, and the pipes which carry water, gas, etc., under the surface. What proportion of these could have existed without it? It matters little what its price is, provided that price is stable. The industries of a nation depend upon the actions of an aggregation of individuals. When the individual considers an expenditure for a permanent improvement, and finds that improvement will cost 50 per cent. to 100 per cent. more than it would have done a year before, or is likely to do a year later, he acts, and that action is almost invariably a postponement of that improvement.

This, in a nutshell, is the reason that industrial depressions follow an abnormal advance.

Iron is a powerful instrument for good when under control, and just as powerful an instrument for harm when not under control. It is not under control when it advances in price 80 to 100 per cent. above its normal cost.

To illustrate how inevitably these depressions follow each abnormal advance in iron, I give Table D, page 649, in which the low prices, the high prices, and the crises of depressions which followed each advance are given in heavy-faced type. A careful review of the authoritative publications upon the subject reveals the fact that the conditions of each of these seven periods of abnormal advances in iron were identical in their train of events, and the advance of 1899 is no exception to the rule. First, there was a revival of industries, such as occurred in 1897 and 1898, during which the employment of workers was gradually, but very greatly, increased. This brought about a corresponding increase of earnings, amounting to thousands of millions. The earnings being largely in excess of the products, these surplus earnings were used, first, in a more generous indulgence in the comforts and luxuries of life, then in investments in existing wealth, particularly that represented by bonds, stocks, and certificates, because these are more easily transferred. This advanced securities to something like their real value. Later, investments were made in permanent improvements, such as houses, factories, railways, etc. This last brought about a sudden and enormous advance in the price of pig iron, because the conditions surrounding its production made it impossible to increase the supply rapidly enough to meet the demand. All the other staples could easily have been provided in quantities sufficient to have met the demand without abnormal advances in their price, because increased supplies are quickly available. Thus, of lumber, two or three years' stock is always carried, and brick,

stone and coal can always be adequately and quickly supplied by simply increasing the workers in brick yards, stone quarries, and coal mines. But of iron we have carried for the last ten years less than twenty-three days' production, and it takes a year to build a furnace. Consequently, in each period of revival in the industries of the world, iron consumers became alarmed through fear that there would not be enough to supply all demands; each buyer made an effort to contract for sufficient to supply his needs, and this being impossible to accomplish, prices advanced rapidly until they reached 80 to 100 per cent. above cost. These advances in iron invariably occurred before there was any material advance in the prices of the other staples. If the other staples were subject to the same conditions which control iron, they would have advanced when it did. When the advances in the other staples came, it was not from necessity, but simply because the advance in iron gave the holders of other staples excuse and opportunity. If the advance in iron had not exceeded 10 or 15 per cent., the advance in the other staples could not have been greater, and prosperity would not have been checked. In every period of depression, the check to all constructive enterprises came with the completion of works contracted for at normal figures. Iron was first in each period to show short supply, and the difficulty of procuring anything made of iron and steel existed throughout the entire period of the boom. When that difficulty ceased, the boom ceased and the conditions of industrial depression began their silent and blighting work. Not from lack of money or confidence, but in the very height of plenty and business activity.

Having analyzed the course of events which followed the seven abnormal advances in the price of iron within the fifty-eight years covered by Table D, let us analyze the period of sixteen years which followed, during which time there was no advance which was general or of like magnitude. For this purpose we will use the records of iron prices in Glasgow, Philadelphia, and Cincinnati, as Scotch pig iron was not imported in sufficient quantity to reflect world-wide conditions during this period. Table E, presenting these records in comprehensive form, appears on the following page.

As will be observed, there was no great advance during this sixteen-year period, and when an advance occurred in one place it was only partially responded to in the others. There was no general advance which stopped the great building enterprises, and consequently no long-lived industrial depression. There was a financial panic in 1890, induced by the Baring troubles. It had effect upon the indus-

tries in 1891, but they were unusually prosperous again in 1892. There was a very severe financial panic in the United States in 1893. This paralyzed everything for a time, but the industries were more prosperous than ever in 1895. There was a severe money stringency during the presidential campaign of 1896, but it was not rated as a financial panic, and business quickly revived early in 1897. This period of sixteen years illustrates the fact that financial panics are short-lived.

TABLE E. COMPARATIVE IRON PRICES FOR SIXTEEN YEARS.

	Glasgow, Scotland.		Philadelphia, U. S. A.		Cincinnati, U. S. A.	
Year.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.
1883	44/2	48/3	21.	25.	18.	22.
1884	41/3	43/5	18.50	20.50	15.50	19.
1885	41/1	42/10	17.75	18.25	15.50	20.
1886	38/4	43/3	18.25	20.	17.	23.
1887	39/5	46/4	20.50	21.50	16.	21.50
1888	37/10	42/	18.	21.	14.75	19.
1889	41/3	61/5	17.	19.25	15.	20.50
1890	44/7	61/1	18.	19.90	14.50	18.50
1891	43/8	51/2	17.50	17.75	13.25	17.50
1892	40/10	45/11	15.	17.50	13.25	17.
1893	40/9	45/3	13.75	15.	12.25	15.50
1894	41/9	43/8	12.50	13.37	11.	14.25
1895	41/4	47/10	12.	14.50	11.75	16.40
1896	45/10	48/7	12.50	13.56	12.	15.
1897	44/2	48/4	11.75	12.75	9.25	11.
1898	45/10	49/7	11.25	12.	9.50	10.50

When panics result from and occur during seasons of great industrial depression, they get the reputation of being long-lived. But it is in reality the effect of the industrial depression which is long-lived. Panic effects pass away long before the recovery from the effects of industrial depressions. The industrial depressions of 1837 and 1857, both of which were attended by financial panics, continued no longer than the industrial depression of 1874, which was not attended by financial panic.

These violent and wholly unnecessary fluctuations in prices, which we call booms, disturb all business, but their greatest injury is to the pig-iron producers. The building and reviving of furnaces is unduly stimulated. This results in disaster to many, and undue lowering of prices to all, on the reaction. The financially-strong producers must accept prices which the weaker ones are forced to make; thus prices are carried abnormally low. Nearly the entire period covered by booms is occupied by the industrial world as a whole in filling low-priced contracts. By the advance in prices of labor and raw materials,

many lose on contracts which, but for the advance, would have paid a profit. The boom is attended by high wages and frequent strikes for higher. The decline is attended by constant strikes to resist wage reductions which manufacturers must make to save themselves. Workers lose more by idle months than they gain by the temporarily advanced wages. The business world as a whole gets no benefit from booms. Stripped of all of its disguises and illusions, a boom is simply a cruel and disastrous blow to the industrial world.

The increase in the buying power of the people, which comes from increased employment, is natural and beneficial. Such earnings come with regularity as a reward to the worker. They are substantial, and as a rule are expended in a prudent manner. They are absorbed naturally by all branches of business and are wholly beneficial. The increase in earnings which comes suddenly from abnormal advances is temporary and unnatural. It over-stimulates business and speculation; it raises values, particularly those most easily transferred, such as stocks and bonds, to abnormal figures. It is an illusory profit, and encourages unwarranted expenditures. When the inevitable decline to normal prices takes place, it brings disaster.

No reformation is needed in the business connected with producing and marketing the necessities of life. The government commissions have discovered that trade in food and clothing is attended with comparative uniformity, in magnitude and in profits, in bad times as well as in good.

All industries may be divided into two classes—production of daily necessities and production of permanent wealth. It is the last which suffers from abnormally high prices. We can stop building, but we cannot stop eating. When the price of iron is under proper control, the industries connected with building will be as uniformly profitable as trade in food and clothing.

The only possible way to bring iron under proper control is to accumulate, in each of the iron-producing countries of the world, a stock of pig iron equal to several months' production. It will not suffice to do this in one country only. The demand from the others would carry its price up with theirs. Each country must accumulate an adequate reserve stock of its own. If this be done during the next few years, there will be no more periods of boom and no more periods of industrial depression, except such short temporary interruptions as may come from financial panics; in time, they, too, may be understood and prevented.

If the manufacturers of building materials would, at this juncture,

voluntarily and promptly, put down prices to within 10 per cent. of normal figures, which is as low, also, as they should ever have gone, even in periods of most marked depression, it would revive a large number of the building enterprises which are now postponed or abandoned, and a prolonged industrial depression might even at this late date be averted. If, on the other hand, prices are held up, until sales are forced by the accumulation of excessive stocks made at high cost, then heavy losses and failures will occur, confidence will be lost, and no amount of reduction will revive the postponed enterprises, until the iron-producing nations have passed through just such another industrial depression as has heretofore followed each abnormal advance in the price of iron.

There is a wonderful future for the iron business the day these violent fluctuations in its price are ended. The annual consumption of iron in the United States is growing with a cumulative force. Fifty years ago it was 100 pounds per capita, two years ago 300 pounds, and last year 400 pounds per capita. Within twenty-five years it should be 1,000 pounds. Not one-twentieth of the inhabitants of the earth are comfortably housed, fed, and clothed. The world is not finished. There are whole continents to be developed. There is plenty for all to do. Let everyone work who will. It requires a certain number of workers to produce the daily necessities of the people. Every additional producer put to work adds to wealth. When the price of iron is under control, the manufacturing nations will make such regular and uninterrupted progress as will astonish the world.

Iron is the most valuable gift nature ever bestowed upon a nation. The owners of the great iron properties have an opportunity of untold wealth within their grasp. They may, by wise action, change a business which in the past has been attended by one or two years of profit, followed by seven or eight years of loss, to a business of uninterrupted profit.

The act which puts an end to seasons of industrial depression will inaugurate an era of unexampled prosperity to the iron-producing nations of the world.

CHINA IN REGENERATION: AN EPOCH AND AN OPPORTUNITY.

By John Foord.

IN a mad carnival of blood and rapine, a new China has been born. The change might have come otherwise—could have come, one is tempted to believe, had the crime of September, 1898, not been accomplished with the tacit consent or active sympathy of the representatives of the Great Powers of the west. An awful price has been paid for the trustful optimism of the legations, and the policy of creating trouble by seeking to avoid it, which has been so much in favour in quarters to which the Chinese reform partly looked for encouragement and support. The story is all the more ghastly because of the warnings, loud and frequent, which preceded the final catastrophe, but it is not the first time that those who lived nearest the crater of a volcano were least regardful of the premonitory rumblings that precede a great eruption. All the world has seen and shuddered at the dire sequel of the policy of opportunism in the foreign dealings with the corrupt, unscrupulous, and woefully ignorant Government at Peking. But the awakening has been too horrible to permit of a lapse into indifference again. Let diplomatic precedent be strained as it may, order must come out of this chaos of savage passions and mad ambitions, and a regenerated China will be the result. Punishment, just and exemplary, must have its course, which should, however, be all the shorter because those primarily responsible for all the nameless atrocities of the reign of terror are high in place and power. But reconstruction must go hand-in-hand with judgment, if one-fourth of the human race is to be saved from falling a prey to the contagion of their own lawless passions, manifested on a scale unheard of in the history of mankind.

In an article on recent industrial progress in China, by Mr. J. S. Fearon, and Mr. E. P. Allen, published in THE ENGINEERING MAGAZINE for November, 1898, the statement was made, that "It is to the interest of western nations that the central authority in China shall be upheld, and particularly is it to the interest of the United States." The world has just seen the collapse of that Government, but it remains true that, among all the nations of the world, none has a more

direct interest in the restoration of its integrity than the United States. The American Government recently went out of its way to obtain assurances from all the great powers of Europe that the principle of equality of commercial opportunity would be respected, no matter what extension might be secured of their so-called spheres of influence in China. But there are other ways of interfering with trade than by hostile tariffs or discriminating duties, and, in the event of the dismemberment of China, we should have to deal with spheres of sovereignty rather than spheres of influence, and equality of treatment for "foreign merchants" would be quite compatible with totally different treatment for the merchants belonging to the nation which happened to be in possession. As Messrs. Fearon and Allen put the case: "The destruction of the general Government at Peking would mean a breaking up of the Empire along the lines of provincial cleavage, and that would entail a serious retardation of all progressive measures of Imperial dimensions now projected. Fancy the difficulty of constructing, and the greater difficulty of operating, a railway from Peking to Canton, across half a dozen frontiers, with innumerable taxes to pay and endless official interference to oppose. Such a condition would not be permitted to remain, and the destruction of the Peking Government would therefore be the signal for a final and irrevocable partition of China, in which the United States would scarcely have a part."

A tremendous impetus must be given to all forms of business enterprise in China by the restoration of law and order on a more secure basis than they have recently occupied. The enemies of reform were also, of necessity, the enemies of the foreigner, and there could be no safe compromise between the policy of reaction and that of progress. The process of going backward inevitably resulted in the liberation of the forces of disorder, of which the world has just witnessed the tragic results. The resumption of the forward movement, which was so violently interrupted two years ago, will carry with it the guarantee of a more prosperous, more contented, and better-governed China. The cataclysm which has rendered impossible the perpetuation of the power of the Empress Dowager and her knot of reactionary advisers has opened up China to the world no less surely than the disappearance of the Shogunate marked the beginning of the new era in Japan.

If the prospective trade of the United States with China is to be measured by the progress of the last few years, it is likely to assume a fairly impressive total. Its value in 1892, exports and imports, was

16,846,555 Haikwan taels; in 1899 it was 43,974,460 Haikwan taels. The trade of no other commercial power, save Japan, shows an equal ratio of increase. These figures exclude the trade of the United States with Hong Kong, whose dimensions are only partially indicated in the returns of the Bureau of Statistics of the United States Treasury, since a considerable portion of it went or came by way of England. The direct trade of the United States with Hong Kong, which was valued at $5,657,472 for the fiscal year 1892, was $10,211,799 in 1899. As the American consul at Che Foo has pointed out, in 1897, the value of American sales to China exceeded those of all continental Europe, including all the Russias (European and Asiatic) by $320,281; in 1898, this excess had increased to $4,171,934, and in 1899, to $6,191,836.

But the magnitude of the commercial opportunity in China is not to be measured by any rate of growth already established. Foreign trade has merely scratched the surface of the possibilities of China, and, given the slightest increase of the purchasing power of 350,000,000 of people, the results would assume stupenduous magnitude. This increase may come in several ways. The vast latent resources of the Empire have been indicated in previous articles in this Magazine, and are sometimes referred to as involving a most formidable source of competition with the industrial activity of the west. As all the experience of mankind has shown that increase of wealth means increase of wants, it should hardly be necessary to combat the fallacy that the development of China would not benefit all the rest of the world. To equip China with the appliances of modern civilisation is not a task to be finished in one generation or two, and, in the course of doing it, a fourth of the human race will be raised to a new standard of living, and things which are now the luxuries of the well-to-do will become, as they have done elsewhere, the necessities of the day labourer in the near future.

With the pacification of China must come a reform of its whole economic and administrative system. There can be no guarantee for the maintenance of order while corruption runs riot in the palace, and no security against the recurrence of popular outbreaks if the people are to be taxed to support a thieving horde of useless officials. Great as the undertaking of putting new life into the Government of China undoubtedly is, there are native Chinamen quite equal to it, if those who direct affairs from Peking, or some new capital, do not demand corruption as the first requisite of public service. We must assume it to be possible for a combination of the powers vitally interested in the

preservation of China to establish, support, and guide a central government which would not be foredoomed to become a prey to its own rottenness. A sound and progressive system of rule could have been begun two years ago, and all that has happened since has only served to bring out in stronger relief the vital necessity of the reforms initiated by the Emperor, and not at all to lessen their practicability. One of the first achievements of such a government as is urgently demanded by the necessities of the situation, because one of the most powerful aids to the redemption of China, would be the carrying out of a comprehensive scheme of railway construction. That has already had a definite start and the results have been most encouraging. Its general outlines may be assumed to be indicated by the concessions applied for by the various financial syndicates and more or less securely guaranteed. In its annual report, recently issued, the China Association of Great Britain gives the following summary of railways actually built, in course of construction, or projected, throughout the Empire:

(A) Railways completed and working:

1. The Imperial Chinese Northern Railway from Peking to Tientsin and Shanhaikwan (with extension to Sinminting and Newchwang nearly completed).

2. Peking to Paoting-fu (built by the Chinese Government, but incorporated as part of the Lu-Han line).

3. Shanghai to Woosung (built by the Chinese Government, but to be incorporated as part of the Shanghai-Soochow system).

(B) Railways in progress or projected, for which concessions have been granted to:

1. Russia, for the so-called Chinese Eastern Railways in Manchuria.

2. The Russo-Chinese Bank for a line from Cheng-ting (a station on the Lu-Han line in Pechili) to Taiyuen, the capital of Shansi.

3. A Franco-Belgian Syndicate for a line (known as the Lu-Han) from Peking to Hankow.

4. An American Syndicate (which has agreed, since, to share its interests with the British and Chinese Corporation) for a line from Hankow to Canton.

5. Germany, for a railway triangle—from Kiaochow to Tsinan, Kiaochow to Yi-hien, and from Tsinan to Yi-hien in Shantung.

6. An Anglo-German Syndicate for a line from Tientsin to the Yangtse opposite Chinkiang.

7. The British and Chinese Corporation for lines:

(a) from Shanghai to Soochow and Nanking.

(b) from Shanghai to Hangchow, with possible extension to Ningpo.

(c) from Pukou (opposite Nanking) to Hsinyang, a station on the Lu-Han railway, in Honan.

(d) from Canton to Kowloong.

8. The Peking Syndicate (British) for lines:

(a) from Taokow on the Wei River to Weihwei and Tsechow.

(b) from Tsechow via Honan-fu to Siang-yang on the Han.

9. France, for lines from:

(a) Pakhoi to a point not yet determined on the bank of the West River (presumably Nanning).

(b) Lungchow (on the frontier of Tongking) to Nanning or Pésé.

(c) from the frontier of Tongking (presumably Laokai) to Yunnan-fu.

(d) Kwangchow Bay, across the neck of the peninsula, to Om-pu.

It will be observed that American interests cut no great figure in all this projected construction, being confined to the Hankow-Canton project. But, for all essential purposes, American and British interests in China are identical, no less in the matter of railroad construction and equipment than in the general field of commerce. Neither British nor American manufacturers want anything more in China than a fair field and no favour, and the promoters of no enterprise appealing to British or American capital are bound by any conditions as to the market from which they are to draw their materials. It is otherwise with the Belgian, French, and German syndicates, all of which agree to buy nothing from foreign sources unless at the call of absolute necessity. Russia's disposition to draw part of her railway material from the United States has always been more or less dependent on her success in borrowing money there to pay for it. In short, tested by their actual practice, rather than by their promises, only Great Britain, the United States, and Japan can be confidently reckoned on to stand for the maintenance of equality of commercial opportunity throughout the Chinese Empire, and consequently to stand for the preservation of its integrity. Of the three, the influence of the United States is likely to be the most potential in saving China from dismemberment, since not the faintest desire is felt in that country to possess a yard of Chinese soil by "lease" or otherwise. The absolutely disinterested position which the United States Government occupies

in relation to the greatest of all the problems now before the civilised world almost necessarily renders the side which it may take in the settlement of China's future the most powerful one. It has only to speak with sufficient decision and show its readiness to act with sufficient resolution to have its decision respected.

Every productive interest in the United States has an obvious stake in the preservation of the Chinese market, alike for the present and the future. The pinch of interrupted business in North China has already been felt by cotton mills both north and south, and the stoppage of this outlet for the one important branch of textile exports would entail serious losses on the people who have invested millions in southern mills on the faith of its continuance and development. The bulk of this part of American trade with China happens to be done through the northern treaty ports of Tientsin, Chefoo and Newchwang, and the wearers of American drills, jeans, and sheetings are to be found in that part of the Empire which would naturally be absorbed by Russia and Germany in the event of the policy of dismemberment proving the stronger. In such an event, it would be a slender consolation for the people of the United States to be assured that they would still have access to the Yangste valley as a field for trade, because of the magnanimous practice of Great Britain in allowing all the world to come in, without discrimination, wherever her authority is supreme. Only one-tenth of American trade with China is done in the provinces contiguous to the Yangtse, and however great may be the possibilities of that region for American manufactured products, the dictates of ordinary business prudence manifestly demand that all China should be kept open for them, from Yunnan to Manchuria. The Government of the United States missed the chance in the closing weeks of 1897, to arrest the steps taken at that time toward the partition of China; it cannot afford to repeat the easy indifference then displayed to events which were supposed to be none of its concern. Events now in progress more nearly concern the interests of the American Republic than those of any other country, because its position demands that it should be the great power of the Pacific Ocean, and because the vastness and variety of its productive resources clearly designated it as destined to become the greatest manufacturing and trading nation in the world.

THE SHIP-BUILDING YARDS OF THE UNITED STATES.

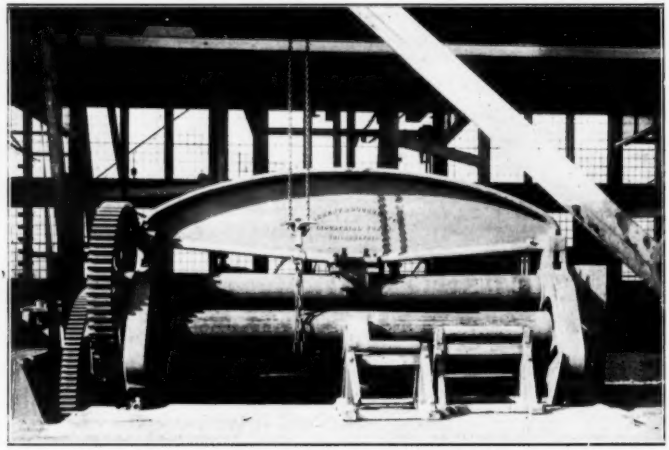
By Waldon Fawcett.

ASIDE from the very largest yards, which were treated in my preceding article, one of the most interesting plants in America is that of the Harlan & Hollingsworth Co., at Wilmington, Del. It is a plant which turns out an immense amount of tonnage and, although there has been built here within the past two years the largest torpedo boat in the American navy, attention is devoted principally to mercantile craft. A specialty is made of passenger and freight steamers for coastwise service. The Harlan & Hollingsworth Company's yard occupies 76 acres and comprises more than fifty iron, brick, and wooden buildings. Motive power for each department is supplied from its own engine room, there being in the yard 15 engines with a collective horse power of 1,500. The water frontage on both banks of the Christiana River aggregates 3,000 feet and twelve berths are provided. The machine shop is fitted with all the latest improvements in metal-working machinery, including one of the largest boring, milling, and drilling machines ever built in the United States. In the blacksmith shop are five steam hammers, ranging from 500 to 2,000 pounds drop, and a press machine and punch capable of punching a 6-inch hole through inch plate. This is operated by a special upright fly-wheel engine and is connected by cog gearing.

The equipment of the boiler shop includes an immense hydraulic riveting plant, having a duplex hydraulic supply pump with 12 by 10 inch steam cylinder, a 7 inch diameter by 14 foot stroke hydraulic ram with ample accumulator, and a patent fixed cast-steel "Atlas" or flush-top riveter with automatic plate-closing attachment, having a gap of

10½ feet in the clear and operated under a pressure of 1,500 pounds per square inch. The last mentioned machine exerts 100 tons' pressure upon the rivet and plate. In addition to all these, there are four traveling cranes of large capacity. A novel feature of the Harlan & Hollingsworth plant is the upholstering department, where not only is the construction of all furniture for ships carried on, but all the linen for vessels is made and marked as well.

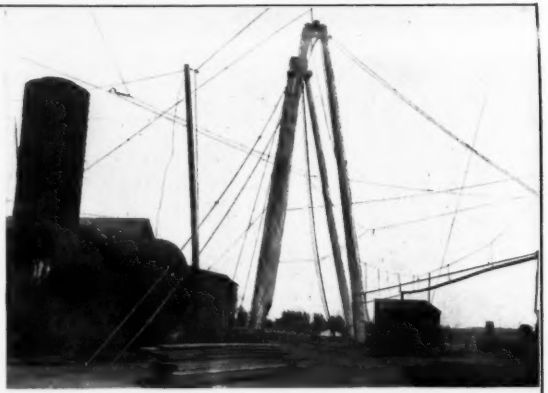
For the expeditious handling of material throughout the plant, the various shops are connected by a net-work of tracks and there is in service an electric locomotive capable of hauling a small train, the motor of which is supplied with power by its own engine and dynamo.



ROLLS, HARLAN & HOLLINGSWORTH COMPANY'S MACHINE SHOP, WILMINGTON, DEL.

There are five erecting shops. All the electrical apparatus required on the vessels constructed by the company is manufactured on the premises, and there is a carving room where 30 first-class carvers are regularly employed. Another distinctive feature is found in the plate racks. The plates stand on edges between upright cast-iron toothed post frames, set in a large circle. They are lifted into or out of these racks by means of a clamp device which automatically adjusts its grip in proportion to the weight of the sheet to be handled, and which is swung from a central derrick. Thus but one operation is required for the transfer of the plates from the railroad car to a place in the racks.

The set of masting sheers at this Wilmington yard is of exceptional interest, by reason of the fact that the greatest possible strength of construction is embodied. The claim is made that this sheers is the



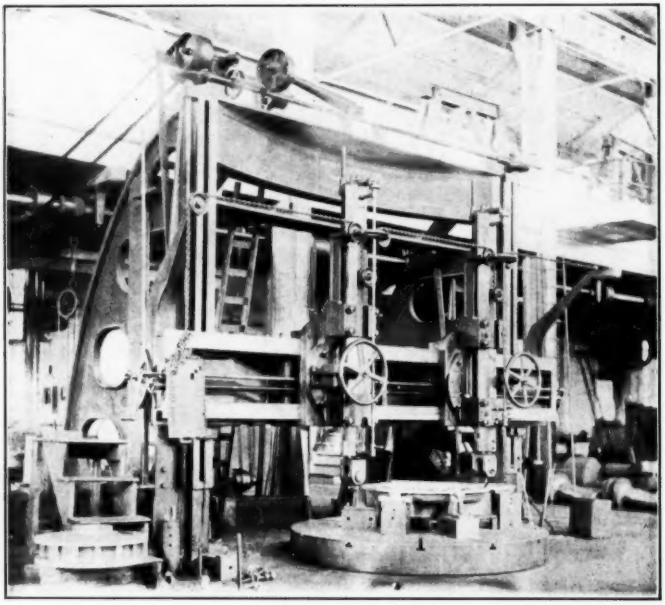
The machine shop.
The mould loft.

The masting sheers.
Gantry crane.

VIEWS IN THE YARD OF THE HARLAN & HOLLINGSWORTH COMPANY, WILMINGTON, DELAWARE.

only one in the United States capable of lifting 150 tons' dead weight without exceeding the elastic limit, the extreme capacity of the sheers being 356 tons' dead weight. The height of the stationary legs of the sheers is 84 feet, and the "reach" from the perpendicular is 50 feet, while that of the leaning pair of legs is 35 feet beyond the wharf front.

In planning a ship, the Harlan & Hollingsworth company follow a method of procedure somewhat different from that observed in many British and European yards. The estimated tables of displacement are prepared first, and a block is then shaped into the approximate form and size required to caliper to the required displacement, after which the actual tonnage at the desired draught is determined by a detailed examination of the weights to be created. The approximate model, embodying as it does all the principles of stability, entrance,

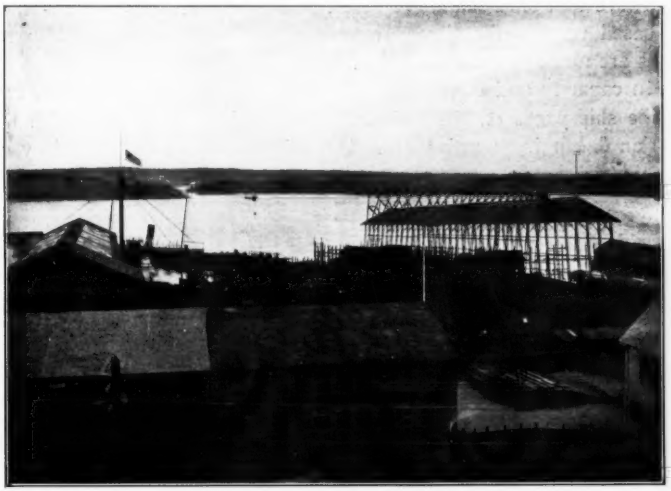


LARGE BORING MILL, HARLAN & HOLLINGSWORTH MACHINE SHOP.

run, flare, sheer, and body balance desired, is smoothed and "faired" down to the exact point of displacement aimed at. After the approval of the model, the course in the mold loft becomes the normal one in general use, save in two minor particulars, *i. e.*, an improved scribing device is employed in connection with drawing in the frames and other

sectional curves upon the floor, and only wooden molds or battens are used as patterns in bending the frames and other angles.

Another feature of ship-yard work in which the Harlan & Hollingsworth practice differs from that at some other yards is in getting a ship overboard. The wedges are, at a signal, driven in and the ship



THE BATH IRON WORKS, BATH, MAINE.
Showing the ship-building shed.

thus raised sufficiently to relieve the strain upon the blocks. When these are split from end to end of the vessel the whole weight rests upon the sliding or launching ways, which in turn lie upon the permanent or ground ways, and the ship would, of course, break away were it not for a thick cross-bracing of tough timber at her bow. The launching cradle is lashed together under the keel by strong rope "toggles" from side to side at intervals toward the bow. The splitting of the blocks is followed by the knocking down, one by one, of the shore braces. Finally the cross-braces which secure the two sets of ways are sawed asunder. A 60-ton hydraulic jack is placed under the forefoot of the stem to give the vessel an impetus in case of emergency. The checking of the ship when afloat is done exclusively by snubbing lines. The British practice of using buried anchors is not employed at all. The time consumed between the signal for wedging and actual start varies, but may be given as from 15 to 20 minutes on the average.

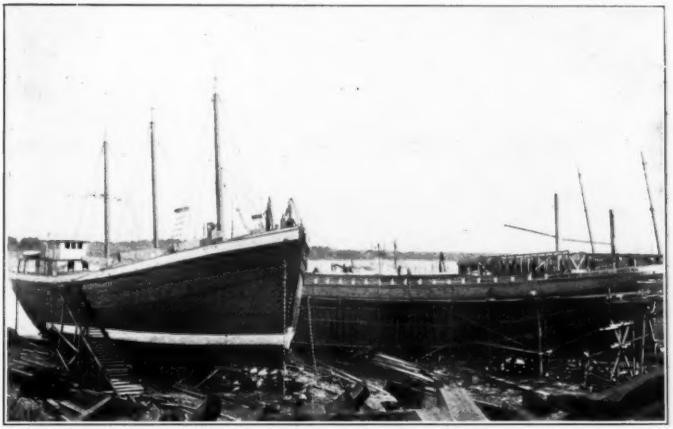
The gantry crane at the Harlan & Hollingsworth yard has a capacity of 7 tons and is operated by electricity. It travels over the entire length of one ways and covers that portion of the yard used for the fitting and riveting of frames and bulkheads. The store system is excellent. The books are kept after the fashion of a regular retail hardware and ship-chandlery store. Sales are registered, and must be based upon authenticated requisitions from foremen. Daily returns are made to the main office.

In capacity and equipment and other general characteristics, two of the ship-yards on the Delaware River might be classed with the Harlan & Hollingsworth plant. One of these is the Roach ship-yard

IN THE NEW MACHINE SHOP OF THE BATH IRON WORKS, BATH, MAINE.

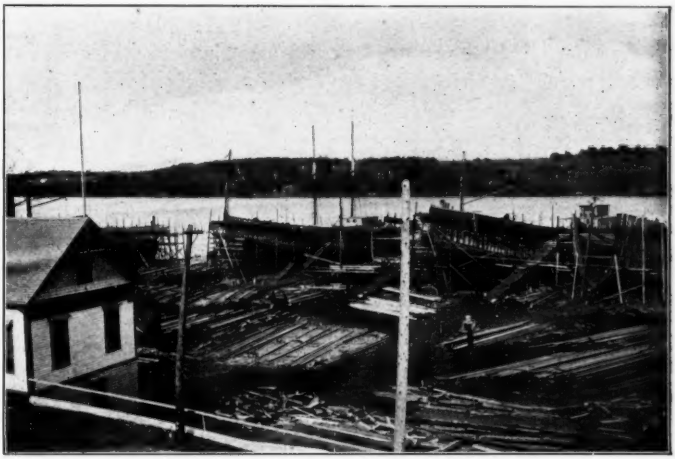
at Chester, Pa., where were constructed some of the first iron and steel vessels built in the United States, and the other is the plant of the Neafie & Levy Ship & Engine-Building Co. at Philadelphia. Neither plant is, of course, of recent establishment, but both have been thoroughly modernized by enlargements and the introduction of new machinery, together with a complete equipment of pneumatic appliances. Both yards have given considerable attention during recent years to the construction of sea-going steel yachts of the highest class.

At Bath, Me., and neighboring ports on the north Atlantic coast are to be found a group of ship-yards which are in many respects very

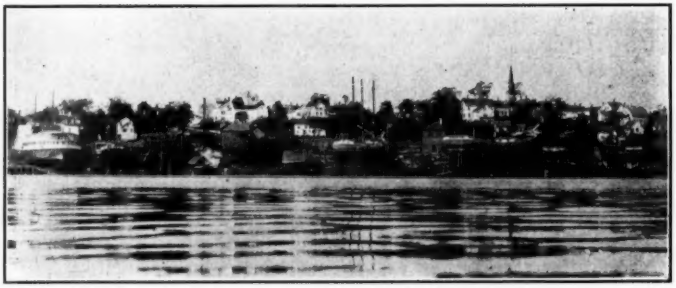


THE YARD OF THE NEW ENGLAND COMPANY, BATH, MAINE.

interesting. Bath was once known as the home of the clipper ship, but with the decadence of wooden-ship-building the aggregate of new tonnage turned out dropped off very rapidly. Of late years, however, the steel-ship-building industry has gained a foothold at the Maine port and has thrived surprisingly, while the creation of a new demand for wooden bottoms for the coastwise coal trade and other lines of traffic has resulted in the reopening of a number of the yards. During



THE YARDS OF KELLY, SPEAR & CO., BATH, MAINE.



YARDS OF THE NEW ENGLAND SHIP-BUILDING COMPANY, BATH, MAINE.

the calendar year 1899—the last full twelve months for which statistics are available—the seven yards at Bath turned out two ships, two schooners, three steamers, twenty-seven barges, and two sloops—a total of thirty-six vessels of 39,120 gross tons burden.

Among the Bath yards first place must be accorded to the Bath Iron Works, which engages in the construction of steel vessels exclusively. The yard gives employment to more than 1,000 men and the weekly pay roll is in the neighborhood of $10,000. Much of the work turned out is of a special class, as is evinced by contracts recently completed, which include a steel naval training ship, the speediest torpedo boat ever built in America, and the most powerfully-engined privately-owned pleasure craft in the world. The Bath Works has also refitted a number of the United States transports, at an expense in excess of $100,000 each. Considerable naval tonnage, including one of the cruisers of the Denver class, is on hand at the present time. The same spirit of expansion so universal among American ship-yards of late is observable in the case of the Bath Iron Works.

MACHINE SHOP AND BOILER SHOP, ATLANTIC WORKS, EAST BOSTON, MASS.

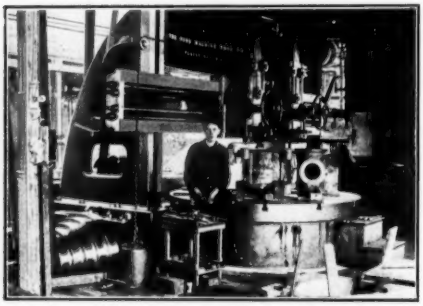
Several new buildings have been constructed within the past year, including a modern brick and steel fire-proof machine shop 310 feet in length by 100 feet in width. There is a steel crane capable of lifting 100 tons, and new tools have been added in all departments, so that the equipment of the plant from the 23-ton plate roller down is now complete in every essential.

The only other steel-ship-building plant at Bath is the yard of Arthur Sewall & Co. This firm was formerly engaged in the construction of wooden vessels, but about five years ago the yard was transformed into a plant for building steel vessels, and a number of steel sailing vessels of 1,800 to 2,000 tons' burden have been con-

SHIP-YARDS OF THE ATLANTIC WORKS, EAST BOSTON, MASS.

structed. The principal concerns engaged in wooden construction are the New England Company and Kelley, Spear & Co., each of which gives employment to between 300 and 400 men.

While the ship-yards of the New England coast are under consideration, attention should possibly be turned to the plants operated in the vicinity of Boston by the George Lawley & Son Corporation, of Boston, the Fore River Engine Works, of Weymouth, Mass., and the Atlantic Works, of East Boston. All three are engaged largely or exclusively in steel ship-building. The Fore River Company's plant at Weymouth, while very complete, was not without limitations in some respects, and the recent securance of important naval contracts

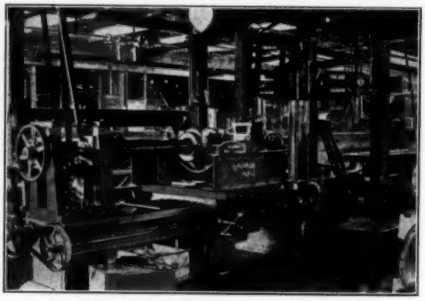


MACHINE SHOP, FORE RIVER ENGINE WORKS, WEYMOUTH, MASS.

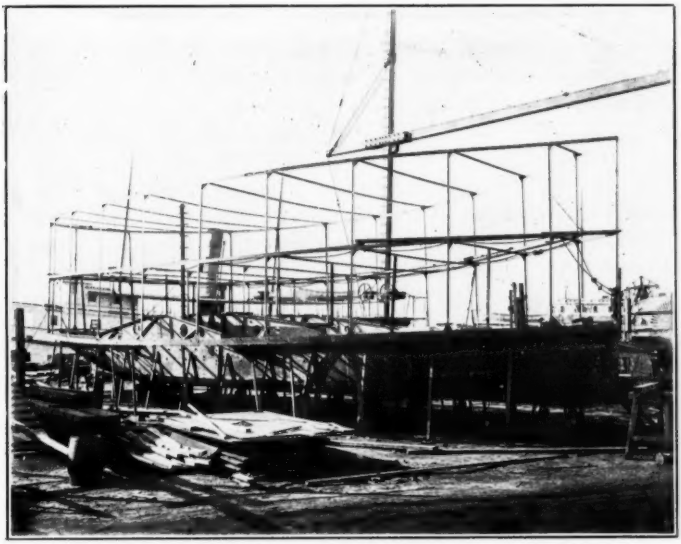
has impelled the company to secure more commodious quarters. The plant is accordingly now being removed to a point further down the river, where deeper water is available. They have here about 60 acres, with a total water front of 1,500 feet on the channel, carrying a depth of 25 feet at low tide and 32 to 35 feet at high tide, with ample width for launching the largest craft. The ship-tool house, now nearing completion, is 390 by 70 feet. The new machine shop will carry in two galleries all the tools in the present shop of the company, leaving the main floor (served by a 25-ton electric crane), free for new heavy equipment. In this will be included four 60-inch lathes, two of which will have beds 110 feet long and two beds 60 feet long. These lathes are designed to turn and bore shafting 45 feet long. There will be a 72-inch lathe for crankshafts, 18-inch slotters, heavy planers, boring mills, and other large tools.

The forge department is to contain three large steam hammers, of 17 tons, 8 tons, and 2¼ tons respectively, besides several lighter hammers. It has a heavy overhead electric traveling crane. Connected with this department will be oil tempering and annealing furnaces.

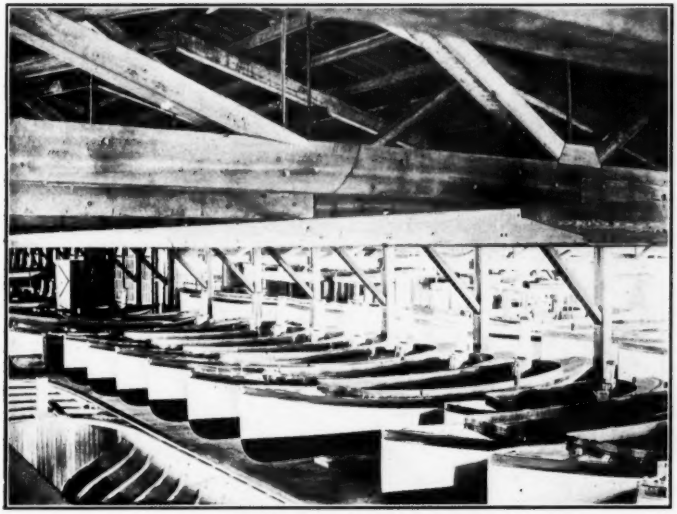
In a separate building is being installed a power plant of 1,000 horse-power capacity, with air compressers for pneumatic tools, as well as the main engines and generators. Electric distribution and driving will be employed throughout, each ship tool, punch, shears, rolls, etc., having its own motor, direct connected. The heavy lathes are being built with a motor substituted for the ordinary cone in the headstock. Locomotive cranes, on tracks in the yards, will serve the various shops.



MACHINE SHOPS, FORE RIVER ENGINE CO., WEYMOUTH, MASS.



STEAMER UNDER CONSTRUCTION IN THE YARDS OF PUSEY & JONES COMPANY, WILMINGTON, DEL.



A GROUP OF COMPLETED LAUNCHES.

Yards of Gas Engine & Power Co. and Charles L. Seabury & Co., Consolidated.

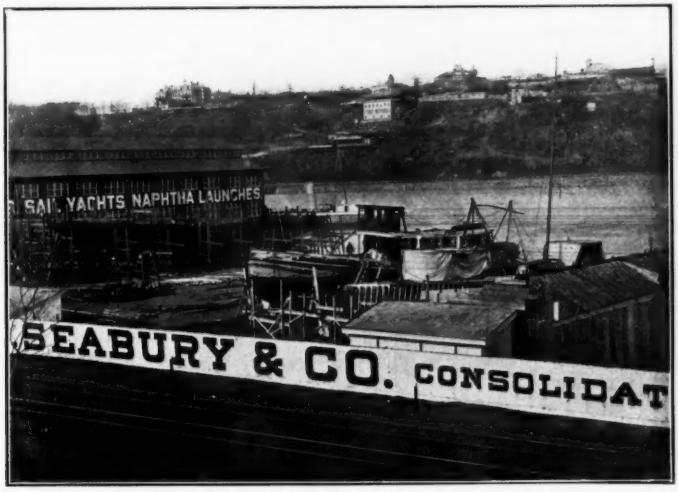
In the same general classification as these Massachusetts concerns might be placed a number of institutions on the Atlantic coast, including the Jackson & Sharp Co., of Wilmington, Del.; the plant until lately operated by the Columbian Iron Works Co., of Baltimore, Md.; T. S. Marvel & Co., of Newburgh, N. Y.; Lewis Nixon's Crescent Ship Yard, at Elizabethport, N. J.; the Gas Engine & Power Co. and Seabury & Co., Consolidated, of Morris Heights, N. Y., and the Pusey & Jones Co., of Wilmington, Del. The yard of the last mentioned company, which might be cited as another representative plant of this class, covers seven acres of land and has a water frontage of 1,400 feet. Some idea of the facilities may be gained from the floor areas embraced in principal buildings as follows: machine shop, 43,000 square feet; boiler shop, 11,000 square feet; blacksmith shop, 9,000 square feet; foundry, 21,000 square feet; tool shop, 10,000 square feet, and others in proportion. There are seven sets of launching ways and a 100-ton lifting sheers. The yard employs from 700 to 1,000 men and the weekly pay roll is in the neighborhood of $7,000 per week. Lewis Nixon built the submarine torpedo boat Holland, and his yard is largely given over to the construction of vessels of some special class. The Gas Engine & Power Co. and Seabury & Co., Consolidated, although they have had a torpedo boat under construction for some time past, devote almost all their attention to steam yachts of all classes.

THE PUSEY & JONES COMPANY'S YARDS, WILMINGTON, DEL.

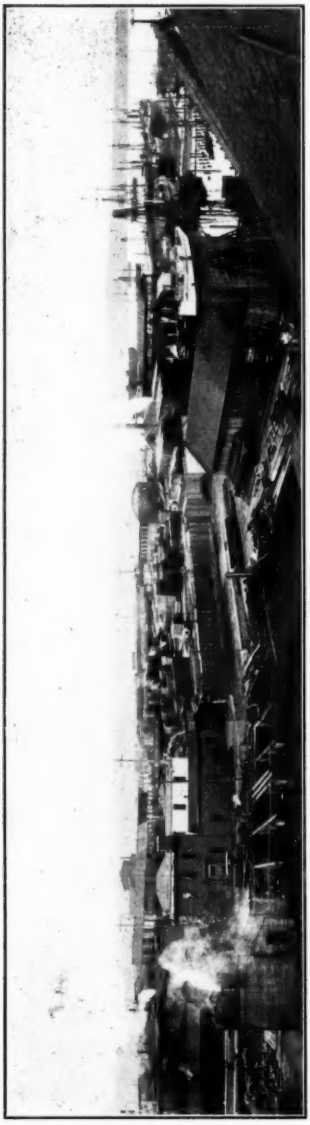
The only yards on the Pacific coast, aside from the Union Iron Works, which build steel vessels—the Wolff & Zwicker Iron Works, of Portland, Oregon, and the Moran Brothers Co., of Seattle, Wash., might be classed with the yards just mentioned; so also might the Iowa Iron Works, of Dubuque, Iowa, practically the only steel-ship-building plant on the inland rivers. The Pacific coast concerns took up steel

WOLFF & ZWICKER IRON WORKS, PORTLAND, OREGON.

ship-building only a few years ago, but the measure of their success in the field may be imagined from the fact that they have each within the past twelve months turned out one or two torpedo boats which exceed



GENERAL VIEW OF PART OF THE YARDS OF THE GAS ENGINE & POWER CO. AND CHARLES L. SEABURY & CO., CONSOLIDATED, ON THE HARLEM RIVER, NEW YORK CITY.



PANORAMA OF THE YARDS OF THE MORAN BROTHERS' COMPANY, SEATTLE, WASHINGTON.

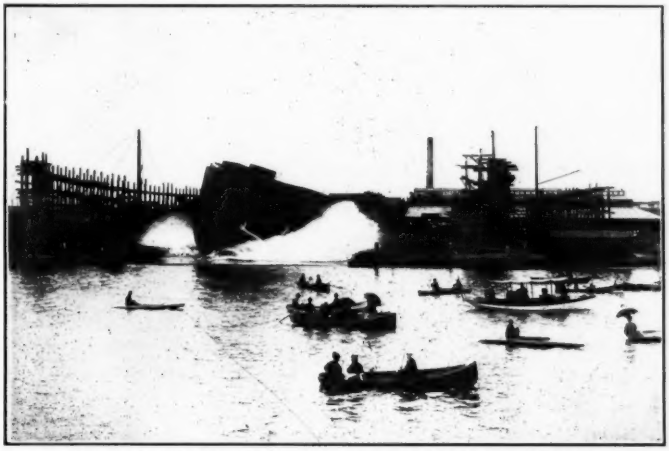
contract speed. Both yards are now crowded with work, including some craft for Alaskan river service. The Iowa Iron Works built a United States revenue cutter and the torpedo boat Ericsson some time ago, but of late have confined their attention largely to steel tenders for the Mississippi River Commission.

The steel-ship-building yards of the Great Lakes have never been in anything like such prosperous condition as at present. In the spring of 1899 the seven or eight principal ship-building corporations on fresh water, including all the largest plants where steel tonnage is constructed, were merged into the American Ship-Building Company. Five of the plants were put in at valuations close to or exceeding $1,000,000 each, and the lowest was $750,000. The consolidation also gave the new company control of the eleven leading dry-docks on the lakes, for, as on the coast, each yard of any size has one or two dry-docks connected therewith.

In the matter of operation, etc., all the principal yards on the lakes are practically identical. The yards of the American Company at Chicago, Ill., and Lorain, Ohio (formerly operated by the Chicago Ship-Building Co. and Cleveland Ship-Building Co., respectively), are the most modern in equipment and may be cited as most thoroughly indicative of the latest

approved practice on the lakes. The Chicago yard occupies about 25 acres, and (as in the case of several of the other lake yards), the vessels are launched into slips at right angles to the river. Inasmuch as the lake builders must launch vessels into narrow waterways, it is the general practice to launch the ship sideways. The type of crane employed for serving material to the ship is the cantilever, with a capacity of 10 tons at the center line of the ships and 3 tons at the extreme length of arm. Five-ton electric cranes are also employed.

At the Chicago yard there is a steel sheer-legs 100 feet high and of 100 tons capacity. There are three legs, the back leg being operated by a horizontal screw to throw the head of the sheers in and out. In

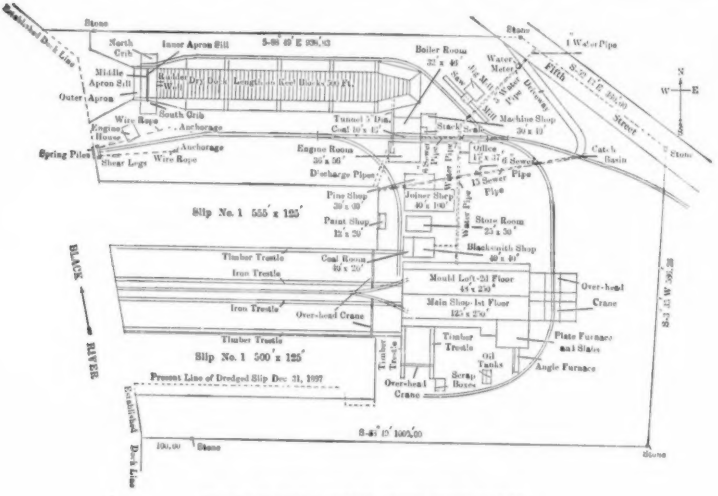


LAUNCH OF THE SIR ROBERT FULTON AT THE DETROIT SHIP-YARDS.

the channel shop is a bending machine which will bend cold a 24-inch I beam between supports four feet apart. All deck beams for the ships are cambered cold on this machine. The machine shop is considered by many persons to be the finest marine-engine shop in the United States. It is constructed entirely of steel and glass. The main portion of the shop is 60 feet in width and 60 feet high. On each side of the central portion is a 30-foot wing. In an area, therefore, 200 feet long by 120 feet wide, there are only eight columns to obstruct the view and arrangement of tools. The central portion is served by a 25-ton electric crane. The larger tools in the shop are driven by independent motors, and in each wing one motor drives a line of shafting from which the small lathes and planers are operated.

The system in use for building vessels in the Chicago yards

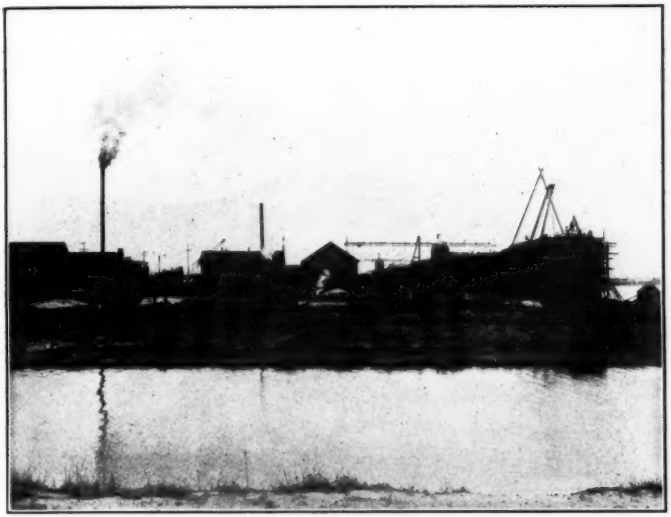
differs not only from the practice of British and European builders but from that in many of the yards on the Atlantic coast of the United States as well. After the estimate of weights on all parts of the vessel has been prepared, a model-block of soft selected pine is procured, large enough to take the half model of the ship on the scale, usually, of a quarter of an inch to the foot. This block is built up of ½ inch strips, solidly glued together with lampblack mixed with glue, showing, therefore, black water lines 2 feet apart. Saw cuts, usually ten frames apart, are put in the block at right angles to its length, and in these cuts are fitted slips of soft red cedar. While finishing the model, therefore,



PLAN OF THE LORAIN, OHIO, SHIP-YARDS.
A typical lake ship-building plant.

the designer has two sets of lines to guide his eye, the water lines and the cedar sections, and all calipering of the model—alleged to be inaccurate as well as tedious—is avoided, as the cedar moulds can be easily slipped out at any time and placed on paper, and a pencil run around them gives a perfect body plan in a very few minutes. When finally finished, a final body plan is made and scaled and a table of dimensions from it sent to the mold loft. In the loft all of the keel, center vertical keelson, frames, bulkheads, side and deck plating, etc., are laid off and punched from the molds entirely.

In the construction of the ordinary lake vessel of the larger type, a double-bottom ship, the keel and center keelson, with all the angles

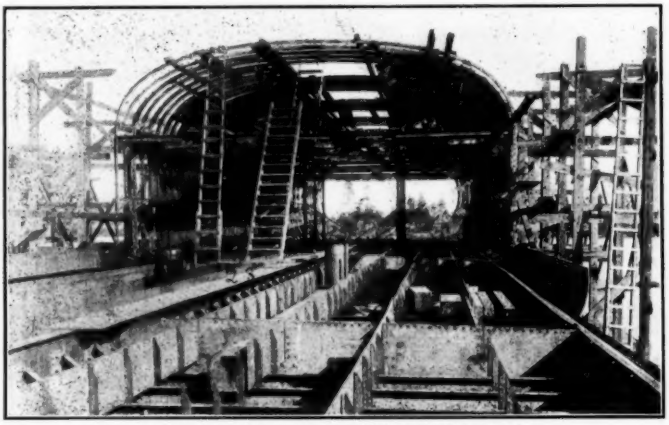


AMERICAN SHIP BUILDING COMPANY'S YARD, WEST BAY CITY, MICHIGAN.

attached thereto, are erected in position on the blocks, riveted and caulked; then the bottom plating is put up and shored. In the meantime the floors, which are usually of channel section, with the bilge

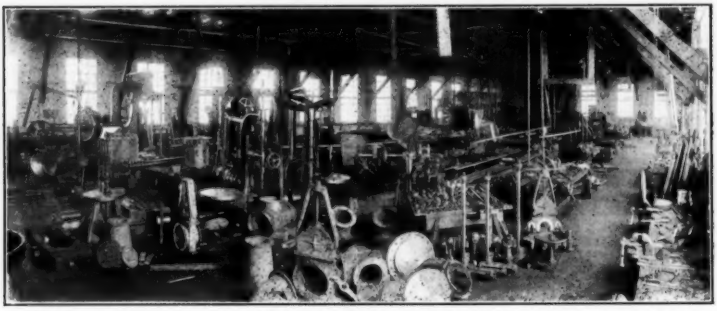
YARD OF THE DETROIT SHIP-BUILDING COMPANY.

brackets, center-keelson brackets, and the stiffening angles for longitudinals, have been bolted together in another part of the yard and riveted up complete on a stationary steam riveter. They are then car-



A WHALEBACK VESSEL UNDER CONSTRUCTION.

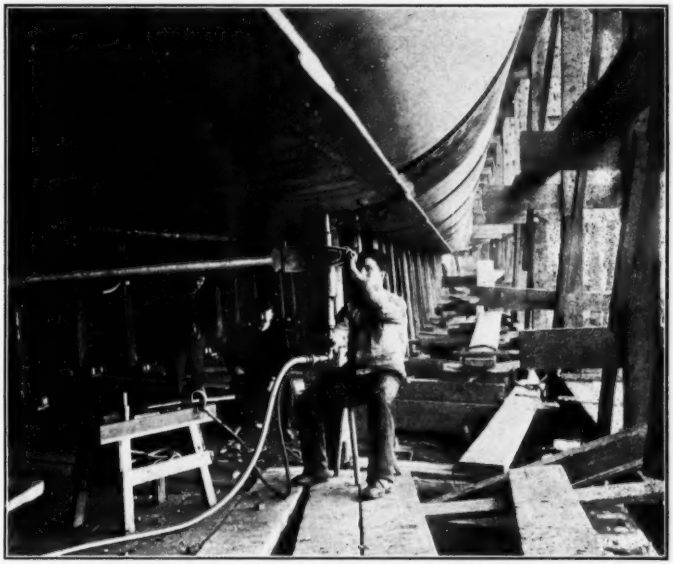
ried to the ship by the locomotive crane and placed in position across the bottom plating by the overhead cranes. The longitudinals are then lowered into the proper place, and as soon as the necessary squaring and bolting is done, the whole bottom is ready for riveting. Almost immediately thereafter the margin plates of the tank top are put on, and the tank-top plating itself. From this point the construction of the ship goes forward in the usual way.



ONE END OF MACHINE SHOP, WOLFF & ZWICKER IRON WORKS PORTLAND, OREGON.

The development of power riveting has perhaps gone further in these yards on the great lakes than anywhere else. Experiments were undertaken with the pneumatic hammer, consisting of a piston rapidly

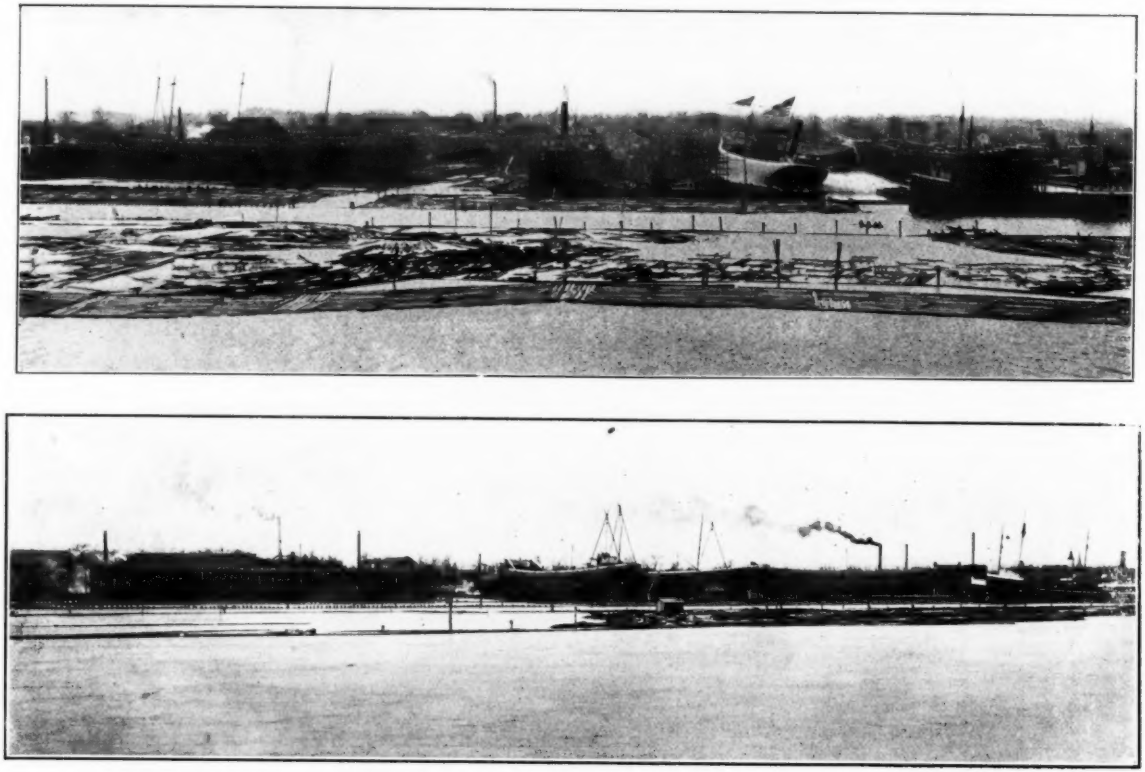
reciprocating inside of a cylinder and striking the end of the chisel, such as previous to that time had been used for chipping and caulking, and it is now possible to drive every rivet in a ship with machines which are very light, short enough to go in between the frames, and of small diameter. The shell rivets are closed up with the greatest ease and facility. A typical air-compressor at a lake yard consists of a vertical tandem-compound engine with cylinders 19 inches and 32 inches diameter by 42 inches stroke, and compound air cylinders 33 and 19 inches diameter by the same stroke, located one each side of the low-pressure steam cylinder. A complete system of jacket water and a



USING PNEUMATIC TOOLS, YARD OF THE CHICAGO SHIP-BUILDING COMPANY.

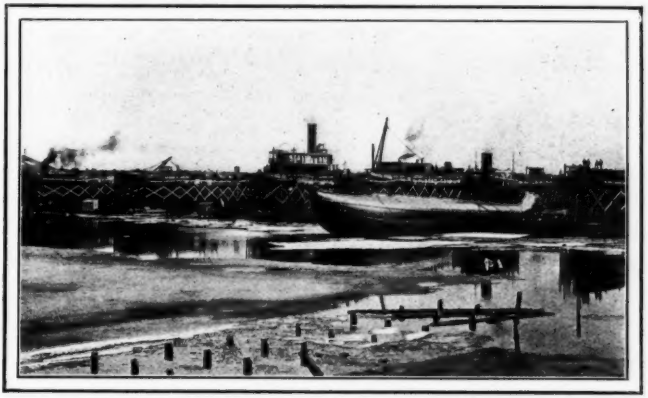
very large intercooler are used, the total capacity of the machine being 3,000 cubic feet of free air per minute compressed to 125 pounds' pressure. From this machine mains are led to all parts of the yard. The magnitude of the pneumatic plants may be imagined from the fact that at the Chicago yard there are in almost constant use over 100 tools.

For launching the vessels sideways or broadside, as is done in all the lake yards, the launching ways are spaced about 10 feet apart from end to end of the ship, and have an inclination of 1½ inches to the foot. Two lines of "sliders," consisting of heavy oak plank, each 30



THE DAVIDSON SHIP-YARD, WEST BAY CITY, MICHIGAN.

to 40 feet long, are placed fore and aft across the groundways on each side of the keel, and one line of short sliders under the keel. All these are cribbed up to the bottom of the ship, tied together, and wedged. At each end three or four groundways are fastened firmly to prevent moving, and heavy wooden levers or triggers about 10 feet long are placed against projections on their sides, used as fulcrums. From these triggers, dog shores, bearing only about one-quarter of an inch outside of the fulcrum, extend up against the keel and the other ends of the levers are set up by tackles to posts set in the ground.

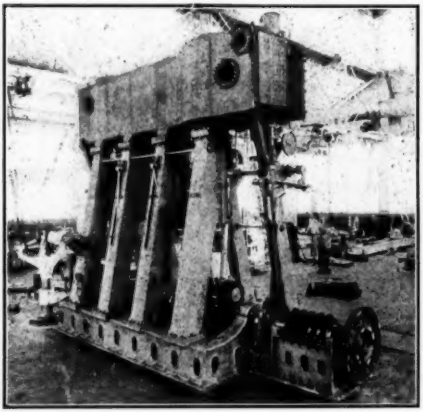


WEST SUPERIOR YARD OF THE AMERICAN SHIP-BUILDING CO.
Here all the whaleback vessels have been constructed.

The first move in the operation of launching consists in the driving in of the wedges and the transfer of the weight from the keel blocks and shores to the cradle. All the shores are then taken out, and all the keel blocks save three or four at each end. The cradle is on the greased ways, but is prevented from moving by the levers and dog shores at each end. When the triggers are released the shores drop out and the ship is in the water inside of 7 or 8 seconds. Boats are often launched with a drop of 2 or 3 feet from the top of the ways to the water, and occasionally there is a clear drop of 5 feet.

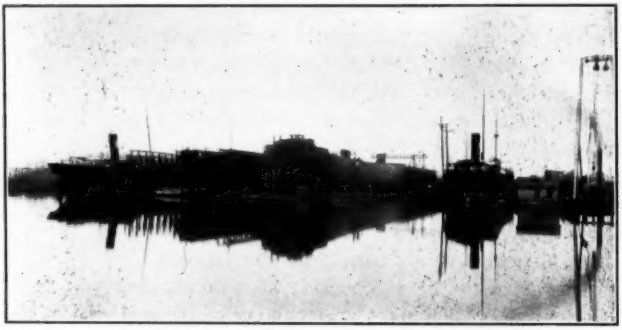
The only one of the large ship yards on the great lakes where wooden as well as steel ships are constructed is that of Capt. James Davidson, at West Bay City, Mich. Outside the "trust," as the American Ship-Building Co. is called, are the Craig Ship-Building Co., of Toledo, O., the Jenks Ship-Building Co., of Port Huron, Mich., and one or two other firms which build steel vessels of what might be called intermediate size. Their specialty is what is known as "Wel-

land-canal-size" steamers—that is, vessels not exceeding 270 feet in length and which can pass through the Welland and St. Lawrence canals. The Craig company has within the past year built two vessels of this size for service in the coasting trade of Puerto Rico, and quite a fleet of steel vessels are now building for service on the lakes in summer and on the Atlantic coast during the winter months. Owing to the provisions of a treaty between the United States and Great Britain, no naval vessels can be built on the great lakes, but several revenue cutters, built on fresh water during recent years, were transferred to the coast during the Spanish-American war and have since remained there.



ENGINES FOR A LAKE VESSEL.
Erected in the machine shop of the Chicago yards.

It may be said in conclusion that whereas the cost of building vessels, both merchant and navy, is at present somewhat higher in the United States than it is elsewhere, all indications point to the approach of a time when superior labor-saving machinery and cheaper material will enable American ship-builders to enter very actively into competition with their rivals in any foreign country.



AMERICAN SHIP-BUILDING COMPANY'S YARD AT LORAIN, OHIO.

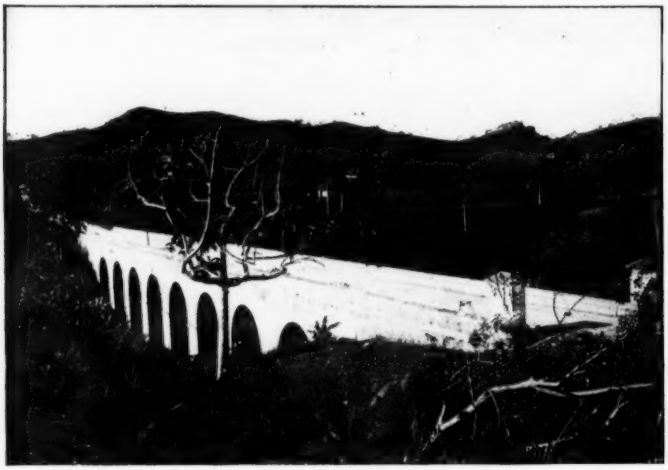
THE INDUSTRIAL DEVELOPMENT OF THE ISLAND OF PORTO RICO.

By Albert W. Buel.

THE thing which has impressed most people from the States, on first acquaintance with Porto Rico, is the lack of transportation facilities. This is apparent to the new arrival just off the steamer as soon as he makes inquiries as to the way to reach this, that, or the other town, and learns that a *coche* is a luxurious express equipage, and a *carretera*, or macadamized road is the "best road" or route of the "fast mail" in Porto Rico. The fare, with such accommodations, for a distance of 130 kilometers (80 miles), is 30 pesos ($18 gold). That is less than 20 cents per mile. If the tourist desires to see any besides the principal towns on the island, he will have to be content to ride over a *camino*, or unimproved country road. For a *coche* to go 32 kilometers (19 miles), half by *carretera* and half by *camino*, the charge will be about 14 pesos. If he wants to come back, it will be more. This is only about 75 centavos or 45 cents per mile. Should he desire to penetrate further into the country, he must ride a Porto Rican pony. The roads will be nothing more than mountain trails, and would be both difficult and dangerous to travel on foot. But the ponies are used to them and are perfectly safe. At present this is the only way the most beautiful parts of the island and the best coffee districts can be reached. Another year the *carreteras* will be extended to almost all points of interest on the island.

The country is not more difficult for railway location than some sections traversed by railroads in the United States. This has led men who ought to have known better to advocate systems of railways across the island. The best road the Spaniards built, and it is a good one, has a ruling grade of 7 per cent. and curves of 20-meters radius. The location is in the main good, although there are a few mistakes in it. The road is much longer than the straight-line distance between the towns connected, on account of the windings necessary to

overcome differences in elevation without exceeding the ruling grade of 7 per cent. A railroad built on the same line could not cost less than $20,000 to $25,000 per mile. This will give some sort of an idea of what a railroad with grades and curves one-third as sharp would be likely to cost. Grades of more than 2 per cent. and curves of not more than 150-meters radius are not nice to contemplate for any steam railroad. Electric trolley roads can be operated over the grades and curves first mentioned. They could not be given franchises on the roads already graded without practically destroying these for use as ordinary highways. New lines can be located for them, and they can be built for probably $20,000 per mile; but the traffic for years to come could not earn 1 per cent. on the investment over and above operating expenses. This refers to trolley roads in Porto Rico in general. It is possible that a short-line trolley road from San Juan to Ponce, connecting communities of 35,000 to 50,000 inhabitants each, and the two chief commercial centers of the island, would be a paying investment. I have good reasons for believing that a line can be located,



BRIDGE ON THE MILITARY ROAD BETWEEN RIO PIEDRAS AND CAGUAS.

not more than 60 to 65 miles long and with grades not exceeding 6 per cent., connecting these two cities. It might cost $25,000 per mile, but would have more than one source of revenue. Should a survey and estimates of cost and probable revenue show that such a road would not be profitable, then any trans-insular railroad project is

ON THE ROAD BETWEEN PONCE AND ADJUNTAS, LOOKING TOWARD PONCE.

chimerical. City and suburban trolley roads will be built and will pay in the larger towns.

The topography of the island has been well described in previous articles in THE ENGINEERING MAGAZINE. The central part is very mountainous, the summits rising to an elevation of 3,000 to 3,500 feet, with the passes at an elevation of some 2,400 feet. The foothills, if they may be so called, run nearly to the sea, and leave a narrow border of low land skirting the island, from 1 to 15 miles wide. Most of the sugar-cane crop is raised in this strip, while the coffee and tobacco is raised in the mountains in the interior. The French railway, of one meter gauge, is projected to belt the island in the border of low land. It has already in operation 69.5 miles, from Carolina to Camuy, via San Juan; 27.3 miles, from Aguadilla to Hormigueros, via

Mayaguez; 26.7 miles, from Ponce to Yauco—a total of about 123.5 miles, leaving about 150 miles to build to complete the belt line railroad projected.

The harbors of the island are not numerous or any too good, and only at San Juan and Ponce has anything been done to improve them.

RAILROAD AND MILITARY ROAD LEADING INTO SAN JUAN.

The expenditure on the harbor of Ponce has not exceeded 50,000 pesos, while about 1,100,000 pesos has been spent on the improvement of San Juan harbor since January, 1883; about 80 per cent. in dredging and the remainder in works more or less temporary. There were projected, during the Spanish *régime,* extensive harbor improvements of a permanent nature for San Juan, Ponce, and Mayaguez, respectively, on the northern, southern, and western coasts. The works to put these harbors in condition to provide economical facilities for commerce will cost a large amount of money, and if a harbor on the southeastern coast is added to those to be improved, the funds likely to be available for this purpose for a number of years will be absorbed by these projects. The great cost of making harbors at many other points, owing to the nature of the coast, puts out of the question any project for a coastwise service sufficient for local traffic.

The island is nowhere wider than 35 to 40 miles, and the distance by road, from any point in the interior to the coast, is not more than 40 miles, and when the roads under construction are finished, 20

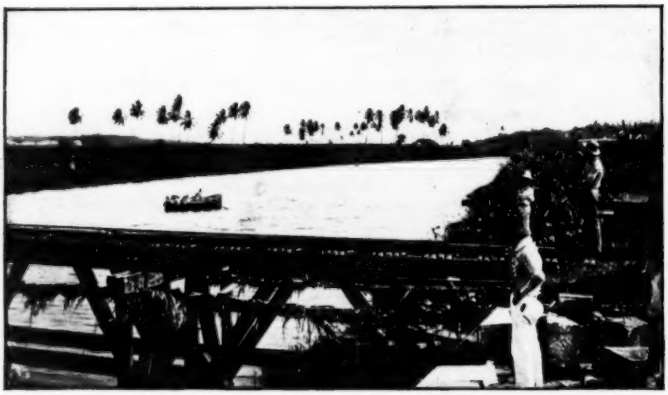
miles ride from the coast will reach most points. The average haul will hardly exceed 15 miles, from the interior to the coast. The direction of the heaviest traffic will always be towards the coast and therefore down hill. It is, therefore, doubtful if trolley roads could get much of the business of hauling coffee and tobacco to the port, in competition with improved highways. The highways around New York city successfully compete with well built and equipped railways for distances as great. Moreover, time is not much of an object in Porto Rico. Of course, sugar is a heavy crop on the island, but the bulk of it is produced near the coast, on the line of the French railway, by which route it reaches, or will reach, the ports.

With these conditions in view we may outline a rational and comprehensive project for the improvement of the transportation facilities of the island: First, construct improved highways direct from all points in the interior to the coast by the shortest practicable lines. Second, construct a highway around the island, and near the coast.

THE FRENCH RAILWAY. SAN JUAN IN THE DISTANCE.

Third, complete the belt-line French railway. Fourth, improve the harbors of San Juan, Ponce, Mayaguez and Jobobs or Naguabo. The last item will cost more than all the other three put together, but it is a *sine qua non*.

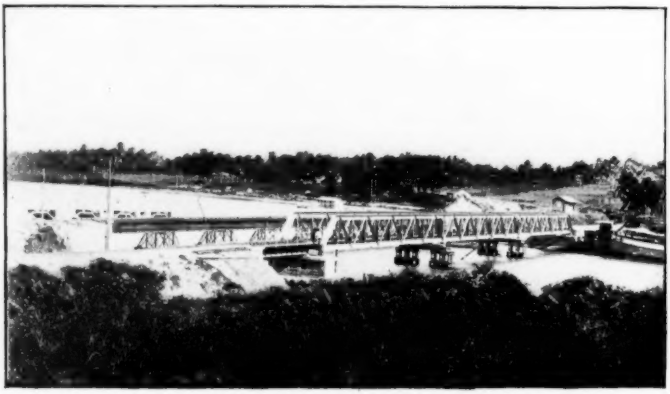
Then all the products of the island can reach the coast by a short



RAILWAY BRIDGE CROSSING THE MANATI RIVER.

down-grade haul, and thence may reach an improved port either by rail or by highway, the latter being a check on the tariffs of the former. Having provided means for carrying the products of the island, we may next devote attention to increasing these products and improving their quality.

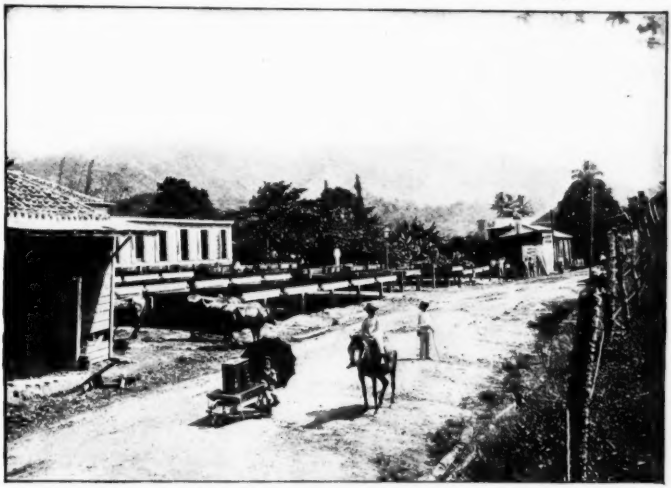
At present the three chief products of the island are, in order named: Sugar, coffee and tobacco. There is considerable cane land not under cultivation, and with proper conditions no doubt the sugar crop can be doubled. The cane mills are many of them in bad repair and use the old process. With improved "sugar centrals" there would undoubtedly be a saving in cost of production.



RAILWAY BRIDGE BETWEEN SAN JUAN AND SAN TURCO.

The coffee of Porto Rico is, in the opinion of experts and epicures, the best in the world—or, at least, unexcelled. It is now a large crop, but the island is capable of producing many times as much. The crop is quite profitable after the first few years.

It may be noted in passing that the very best coffee lands are in the most beautiful parts of the island, and while they are not to-day easy of access, they will be within six months from the time this is written. There are many places that would make ideal winter resorts for those who can indulge in such luxuries. One could have a winter resort in the mountains of Porto Rico that would be a source of profit within



PORTO RICAN AGRICULTURAL INDUSTRIES. COFFEE DRYERS AT UTUADO.

five years. Practically all the work is done on a coffee plantation during the winter months, when the northern owner would naturally be there. The valley of the Rio Grande de Arecibo is certainly unexcelled in beauty by anything I ever saw in the United States. The weather bureau publishes so much literature, with figures, maps and tables, on the climate of the island, that any further remarks on the subject of its perfection are superfluous.

Porto Rico tobacco is not Havana tobacco, but there is more difference in the way the two are handled, cured, and sorted than there is in the leaf itself. I have yet to find a box of Porto Rican cigars that runs uniform. One cigar will be the equal of an Havana, and another from the same box will be mediocre. The improvement in handling will follow the introduction of the tobacco in the United

States market, after which there should be an increase in the demand and production.

The orange flourishes, and is not in danger from frosts that have played such havoc with the groves in Florida. It is confidently believed that the Porto Rico orange crop will in a few years be a leader in the orange market.

The cattle of the island are fair, but the milk is thin and will not produce cream or butter. The stock needs the addition of some Jersey blood. The ponies are small but tough. There is no doubt that any care at all in their breeding would give better results.

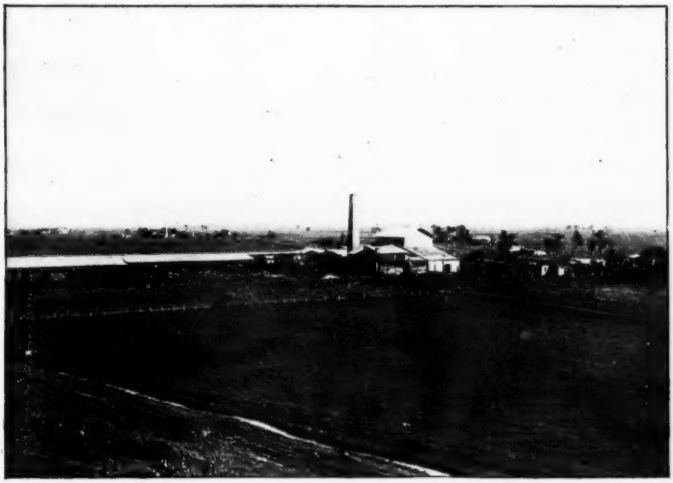
Porto Rico is an utter stranger to emulation, and is not well acquainted with competition. As soon as the highways are constructed it would be wise to divide the island into six or seven districts, with San Juan, Arecibo, Mayaguez, Ponce, Cayey, etc., as the centers of the districts, and institute annual district or county fairs. These

PORTO RICAN PLANTATIONS. HACIENDA LAS CLARAS, ARECIBO.

people take to carnivals naturally, and I have no doubt that they would be a success from the start if properly managed. With prizes of money (or a gaudy decoration) it is possible that some little emulation could be cultivated, to the benefit of the quality of the products of the island. Such fairs would bring out (not for sale) a truly marvelous display of women's work, in laces, drawn work, etc., and also of guava and other *dulce*. If the district or county fairs were held

Sextuagesima week, an insular fair could be held at San Juan during carnival week, which would well be worth the voyage from the States to see.

All the preceding remarks or notes have referred to lines of development that might be hoped to show immediate or quick results. The eventual and proper development of the island, however, can only be attained by that long line that has a generation as its unit of time—



PORTO RICAN PLANTATIONS. HACIENDA LOS CAÑOS.

EDUCATION. The United States military government found the island practically without a school system. True, they had schools; and in San Juan a most creditable high school, judging by the capacity and educational acquirements of its graduates. But they had no school houses.

The civilized world will judge the United States to a large extent by what they do in educational matters, for all advancement rests on education.

The American insular board of education has built one school house, and the entire history as well as the result of the effort is almost an epic on "how not to do it." As an illustration of architectural taste it is barbarous—a blot on a fair island, and representative of the worst taste in America. It is set on a hill and is one of the first objects noticed from the bay. It is very impressive—very ugly and repulsive things usually are—but this is especially so because repulsive architecture is rare in San Juan. Thus the first effort of the new school board

ON THE MILITARY ROAD NEAR MATIN PEÑA, SHOWING A ROADMAN'S HOUSE

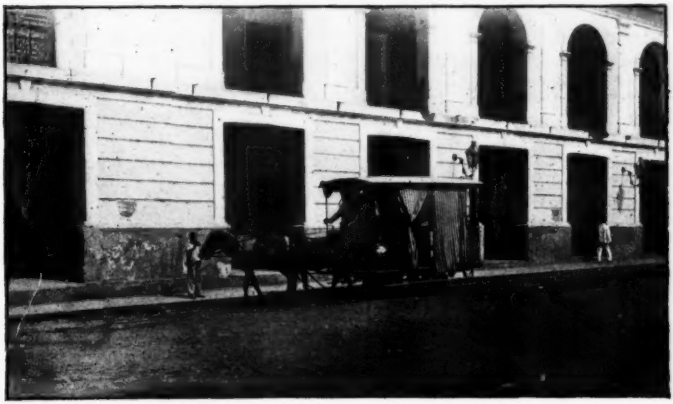
is an example debasing instead of elevating. One's first impression of the "Model and Training School," before reading the sign over the door, is that it is a quartermaster's temporary storehouse. The matter most to be regretted is that this hideous appearance has not saved any money. The building has cost more than the original estimate by two additional appropriations. And now they tell me that it is settling and will not bear up ordinary school supplies. There is one thing about it that is very fortunate—it is not fire-proof.

Other things the insular board of education has accomplished are introduction of American non-Spanish-speaking teachers for Spanish-speaking children, and the substitution of English for Spanish; the appointment of almost illiterate American adventurers to such positions as district superintendents, and the appointment and retention of intemperate men to responsible positions in charge of the schools. It is right and proper enough to introduce English, but the change of language should have occupied several years instead of only one.

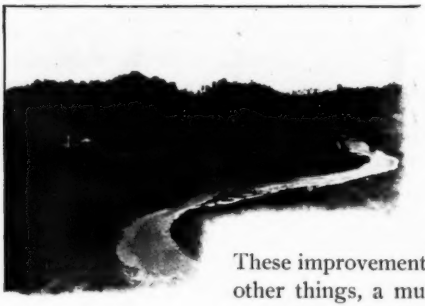
The houses in San Juan are mostly constructed with massive brick walls and wooden beams for both floors and roofs, supporting brick or tile. The roofs are all nearly flat and consist of three courses of brick, each about 1¼ to 1½ inches thick by 12 inches long, laid on 3 inch or 4 inch by 1 inch wood slats or lath, spaced the length of the brick apart on centers. The brick and mortar are of very poor quality, hence the

thick walls are rational. The wood may be one of several native varieties, probably ausaba—a hard, tough, and durable timber, but very expensive. Where the beams enter the walls they soon decay, because the brick are very porous and are always nearly saturated with moisture. The walls are plastered inside and out, and the joists always show in the ceiling, only having their edges chamfered and painted a stripe of blue or sometimes orange. Most of the walls and ceilings are white, with trimming of subdued tints of green. The exterior walls are subdued tints of all colors, and the effect is pleasing. When some enterprising Americans introduce concrete-steel beams here, San Juan will become the most durable and fire proof city in the world. There are few places where concrete-steel has conditions so favorable for competing with wood and steel.

San Juan has good pavements, kept clean by the board of health, using prison labor; it has a water works and the beginning of a good system of sewers. It has three or four paved plazas, but no park. The streets are narrow, very, and there is a congestion and overcrowding hard to find in the United States outside of the lower east side of Manhattan Island. The two causes of this state of things are the ancient inherited desire on the part of everyone to live inside the walls of the old fortified town, and the fact that almost all the available land for extension on San Juan island is, and always has been, government property. Just before the war the Spanish government had arranged to release a large part of this land for the extension of the city, and extensive improvements were planned on it. These were stopped by



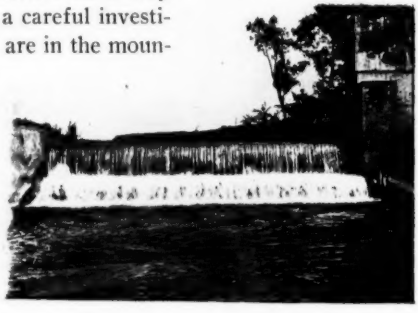
IN MAYAGUEZ. THE ONLY TRAMCAR LINE IN PORTO RICO.



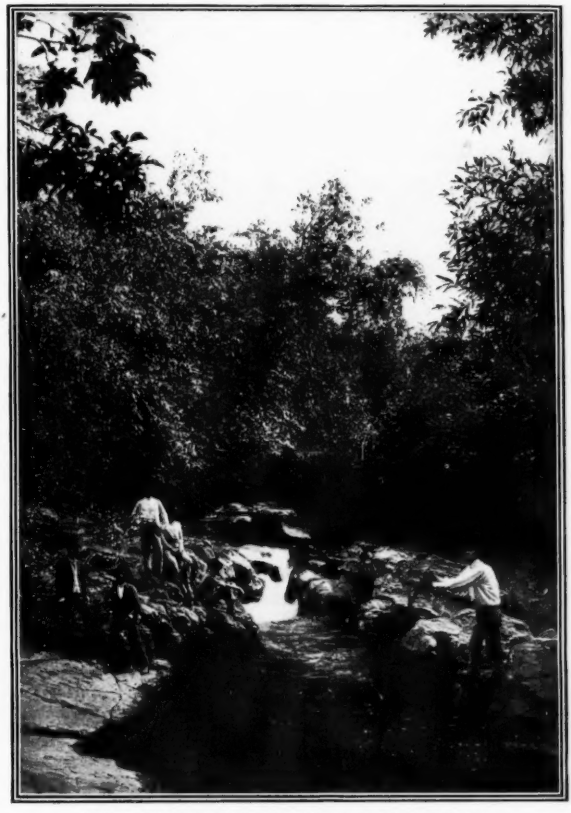
RIO DE LA PLATA, AT TOA ALTO.

the war, and will probably have to await the enactment of the civil government bill by Congress before they can be proceeded with and the unhealthy (both physically and economically) condition of congestion is improved. These improvements ought to comprise, among other things, a municipal park, a hotel to accommodate the increasing number of tourists from the States, as well as others, and some apartment houses. These would certainly be good investment for American capital, considering the demand, the ruling prices, and the small expenditure involved compared with similar projects in the States. With proper accommodations supplied, there is no reason apparent why San Juan and Porto Rico should not be a most popular winter resort.

The opportunities for developing great water powers are so large in comparison with the size of the island that they may be said to be unlimited—that is, physically. Where to find a market for the product, whether it be converted into electric current, compressed air, or any other form of energy, is the question. Certainly there exists already a demand for a limited amount of electric current for both light and power, but whether or not there is a sufficient demand in sight to warrant the development of the water powers and the stringing of the copper is a question that to answer in a way worth anything will require a careful investigation by an expert. There are in the mountains some of the most perfect natural locations for high masonry dams, with the bulk of the material right at hand to build them, that can be found anywhere in the world. The high price of fuel on the island also points to the development of these water powers.



DAM ON BAYAMON RIVER, PALOSECO.
Furnishes power for an ice factory.



PORTO RICAN WATER POWERS. THE RIO COROZAL.

The poor quality of the Porto Rican brick has already been mentioned, but, like almost everything else on the island, its imperfections are not the fault of the raw material supplied by Borinquen—the ancient Indian name for Porto Rico, meaning "the beautiful island." Whoever made this island did a good deal for it; man has, up to date, done almost nothing. There are clays available in quantities for all grades of brick, tile, and crockery. The natives are well adapted to that kind of work, and they only need direction, with the proper plant, to produce excellent results. The island has about one million inhabitants, and would afford a market for clay and pottery works of fair size.

The consumption and imports of Portland cement for the island for the current year will exceed 20,000 barrels. The consumption will increase in future years. If proper raw materials can be found on the island, and there is every reason to believe that they can, the manufacture of Portland cement should prove very profitable. The greater cost of fuel for burning, compared with the cement mills in the States, would be balanced partly, if not entirely, by the lower price of labor. Moreover, for local consumption, it may be shipped in bags, while cement for export over sea must be coopered. The cost of the cooperage will more than offset all other disadvantages. Besides these there is the difference in cost of freight. The present consumption on the island alone would make a nice business for a small mill, and the profits in this business are large, under present conditions of supply and demand. It is quite probable that a well managed Porto Rican Portland-cement mill could eventually supply a large part of the demand for the article in the West Indies, Central America, and the northern part of South America, and could sell all it could possibly make when the isthmian canal is constructed.

Another possible line of development is indicated by the luxurious wild growth of bamboo. The cultivation of this product and its manufacture into various articles, for which the Porto Ricans are peculiarly adapted, might be developed into a flourishing industry.

It has not been my object in these notes either to write exhaustively of Porto Rico or of the subjects touched upon, but rather to suggest some of the lines deserving further and special investigation for industrial development and investments. At the same time, and this is of no less importance, it has been my intention to show that some lines do *not* invite further consideration, at least, not yet.

That Porto Rico is susceptible of wonderful improvement and industrial development is as self-evident to anyone who sees it as that it is one of the most beautiful, lovely, and fertile spots on earth. But nothing can move until the political status of the island is settled. Whether that improvement is about to dawn, or whether the island is to continue to exist as it has for four hundred years, or, as has seemed latterly, while the politicians were using it as a pawn in a game of chess, it is to retrograde, depends on the fulfilment by the American people, their Congress, and their government, of the trust they have assumed. This, I hope and believe, will be carried out with the highest sense of honor.

LOCAL TRANSPORTATION AT THE PARIS EXPOSITION.

By Henry Harrison Suplee.

THE practical problems which present themselves in connection with the operative management of a great exposition are often as instructive as the exhibits themselves.

Nearly all modern cities are now contending with the difficult problem of local transport. In the natural order of things there is a business quarter and a residence quarter, or rather, several residence quarters, and twice a day the human tide flows with an ever-increasing volume. If such a problem is difficult in ordinary circumstances, it is far more complicated when a vast increase in the floating population is made, and when the force of the human current is concentrated upon a comparatively limited area.

In Paris we see these latter conditions carried to an extreme, and the manner in which it has been attempted to meet them may furnish some lessons, not only for the conduct of transportation at future expositions, but also in cities now contending with an acute state of street

A CROWDED CORNER, SHOWING ELECTRIC RAILWAY AND TRAVELING SIDEWALK OVERHEAD.

congestion. Paris is an excellent example because of its nearly circular shape, because of the central location of the exposition, and because the circumstances have rendered possible the use of both rail and water transport, as well as of horse-drawn vehicles innumerable.

Normally Paris has been dependent upon two means of local transport—the omnibus and the cab. To these have been added gradually certain tram lines, using steam, compressed air, and electricity. But these latter have been slow and very limited in capacity. The belt-line railway, running largely in cuttings and underground, has done something to relieve the congestion for such travel as could be reached by its limitations. An additional and more agreeable means of conveyance is

SIDEWALK AND RAILWAY AT THE AVENUE DE LA BOURDONNAIS.

found in the small steamboats plying on the Seine, and making frequent stops on both sides of the river. For many years, however, it has been realized that these facilities were unequal even to the ordinary demands for transport, and in view of the present exposition, numerous preparations were made for improvements.

As a matter of fact, however, none of these improvements has been completed in time excepting those within the exposition grounds. The "Métropolitain de Paris," the fine new underground road, extending from the Porte Maillot to the Porte de Vincennes, on the right bank of the Seine, with a spur to the Place du Trocadero, was almost completed at the opening of the exposition, being "all finished except the finish-

ing," but up to midsummer it had not been opened to travel. Doubtless this route, touching as it does at the Place de la Bastile, Hotel de Ville, Palais Royal, Tuileries, Place de la Concorde, Champs Elysées, Place de l'Etoile, Place Victor Hugo, and the Place du Trocadero, will be of immense value in facilitating transportation between the east and west of Paris, and it will be a most valuable legacy of the exposition to the service of the city. The whole scheme, of which the above is only a portion, is far greater in extent. Section B will follow the line of the old exterior boulevards, thus forming a circle within the present ceinture line. Section C will unite the St. Lazare station, the Opera, the Bourse, and the Place de la République, and connect with the circle at the Boulevarde de Ménilmontant. Section D, starting from the extreme north of Paris, will connect the stations of the Northern and Eastern railways, and will then pass under the Seine near the Louvre, connecting with the Montparnasse station and extending to the Porte d'Orleans on the south. Section E will connect the station of the Eastern Railway with the Austerlitz Bridge, and section F will extend from the Austerlitz Bridge to the Place d'Italie.

Since none of these excellently planned lines was ready for operation at the opening of the exposition, the visitors during the first half of the time have had to depend upon the existing means of transportation, with such slight increase in capacity as had been provided. As a result, nearly every line of conveyance has been most seriously overcrowded. At the omnibus stations, where numbers indicating the order of precedence

THE CROWDED SEINE BOATS.

are given out, the crowds in waiting have extended into the hundreds, while at the boat landings, especially near the exposition entrances, there have been daily long lines of waiting passengers. Much has also been said about the difficulties which have been experienced by the visitors with the cab drivers, but in justice to these latter it should be said that many of the disputes have had their origin in the

INCLINED APPROACHES TO TRAVELING SIDEWALK AT THE INVALIDES STATION.

ignorance of the visitor, or his unfamiliarity with the language, a very moderate advance over the legal rate generally insuring fair service.

As a matter of fact, much of the crowding might have been avoided by a serious effort to augment the existing facilities. A number of additional boats for the river could have been obtained from elsewhere, while a service of electric and steam launches upon the Seine, similar to that so successfully used at Chicago in 1893, would have done much to relieve the congestion. Such launches would have secured innumerable commissions from visitors, since the river forms a remarkable water-way through some of the most effective portions of the exposition, and would have proved convenient and profitable.

The capacity of the omnibus routes, at least, could have been increased by putting on additional vehicles upon the most crowded lines, for in any case a great augmentation in omnibus travel was sure to have been anticipated, while automobile cabs by no means utilized the great opportunity which the exposition offered.

Leaving the question of what might have been, it is more interesting to turn to the operative means of transport within the exposition grounds. These are practically limited to the traveling sidewalk and the electric railway.

The first of these, the traveling sidewalk, while by no means new in conception, is here carried out on a far larger scale than ever before attempted. Extending for a length of 3.4 kilometers around the quadrilateral formed by the Rue Fabert, the Quai d'Orsay, the Avenue de la Bourdonnais, and the Avenue de la Motte-Piquet, it forms a continuous connection between the main portions of the exposition, *i. e.,* the Champ de Mars, the Quai d'Orsay, and the Esplanade des Invalides. The only portions not directly reached are those on the right bank of the Seine, the Champs Elysées and the Trocadero, and these are readily reached by crossing the river by the Alexander III. bridge or the bridge of Jena. The general appearance of the platform is well shown in the illustrations, and its construction was described

CURVES ON THE ELECTRIC RAILWAY AND THE TRAVELING SIDEWALK.

in THE ENGINEERING MAGAZINE before its operative success had been demonstrated. The mechanical operation is very simple, thanks to the ease with which power may be electrically distributed. It is understood that the main platform of 2 metres' width travels at the highest speed, 8 kilometres per hour, while the auxiliary platform, of about half the width, travels at half the speed, the third platform re-

maining stationary. At every 200 metres there is placed beneath the platforms an electric motor, there being 172 motors in all, these being partly of the Alioth type and partly of the Westinghouse. The motors operate shafts extending across the framework, these shafts carrying driving-wheels of two diameters acting upon rails attached to the under sides of the two sections of the platforms. The motors, being carried upon spring suspensions, are held up against the rails driven by them with a uniform pressure, so that unnecessary friction is avoided, and in practice the whole operates remarkably well, there being very little or no jarring or irregularity.

The power required to drive the platform is much less than might have been supposed, varying between 220 and 330 kilowatts (300 to

THE TRAVELING SIDEWALK, SHOWING THE APPROACHES AT THE GARE DES INVALIDES.

400 horse power), according to the load. This certainly appears reasonable when it is considered that the platform itself weighs 1,700 tons, and carries an average of 14,000 to 15,000 persons at a time. As will be seen from the illustrations, the method of jointing the sections of the platform permits curves of short radius to be turned without opening any gap, and although the construction of the whole has necessarily been performed in a very limited time, the appearance is by no means unsightly.

It is especially interesting to observe the ease with which all persons, old and young, of either sex, mount and descend from the plat-

SHARP CURVE NEAR THE EIFFEL TOWER.

form, and even the brief experience which has been had already shows how entirely practicable the system is in this respect for general use. This matter is especially important in connection with the transportation of large numbers of people for comparatively short distances, since a large portion, both of time and energy, are wasted in the frequent stops required by ordinary tramway systems. The movable platform, or traveling sidewalk, enables the entire length of the route to be utilized, and the absence of stops makes up, in great measure, for the moderate speed at which it travls.

Taking into account the remarkable success of the system of Messrs. Blot, Guyenet, and de Mocomble, at the exposition, it remains to be considered how far such a system, or some modification of it, is applicable to general service. For many local purposes it requires practically no modification. Thus, for example, in the long platforms at railway stations, on piers, or for connections between stationary platforms, where large numbers of persons are to be transported for short distances, much of the congestion now so annoyingly frequent might be removed. The same is true in large machine works, where much of the time now lost in passing from one part to another might be saved by a travelling platform and the rush of workmen at the hours of opening and closing transformed into continuous streams without crowding or confusion. Enormous economies have been effected in the handling of materials by use of endless traveling belts and conveyors, and it is probable that similar methods may be installed locally for very many varieties of service.

ON THE QUAI D'ORSAY.

When the question of further extension of the traveling-sidewalk system is considered, modifications may have to be introduced. Higher speed can be obtained only by the addition of a third platform, since the essential feature of the system is the fact that it can be mounted by anyone without difficulty, and experience has shown that the speeds used at Paris are as high as can conveniently be employed. With the addition of a third platform, permitting a speed of 12 kilometres an hour, and using a permanent way similar to that of the elevated railways in New York and elsewhere, such a system would go far toward relieving the streets of a great city of much of the congestion now so objectionable. Its use would permit the employment of higher speed electric tramcars upon the surface, since these latter could then be given longer runs, stopping only at given points instead of at every corner. The natural objection to such a system is that of unsightliness, but it is a question whether it would be more unsightly than many things which it would replace. It has never been maintained that the lumbering omnibus of London or Paris is a thing of beauty, and æsthetic considerations have not prevented the plastering of walls, stations, and public places with glaring advertisements. A suitable elevated structure, of correct proportions and mechanical symmetry, need not be hideous and might be made altogether unobjectionable. If Paris, with all the care which has there been taken to render the city beautiful, can permit the erection of such a structure, it is hardly for London or New York to object on æsthetic grounds.

The electric railway at Paris calls for but little attention. It is doing its work well, but differs little from many other tramways operating elsewhere. Following practically the same route as the traveling sidewalk, but running in the opposite direction, its general arrangement is clearly shown in the illustration. The commercial advantages of both systems will be grasped, when it is realized that they must clear their entire cost, with a fair return to the investors and a royalty to the exposition treasury, during six months.

The demonstration at Paris; first, of the excessive congestion due to inadequate service; second, of the ease with which that service might have been improved, should be a lesson to all great cities.

The city of the future, transformed from the city of the present, will have abundant transportation facilities, beneath, above, and on the surface. Electric power will have superseded the steam locomotive and the horse, and, properly conducted, the transformation will remove far more unsightliness, discomfort, and filth than it can possibly introduce.

THE COMMERCIAL ORGANIZATION OF THE MACHINE-SHOP.

By Hugo Diemer.

III. THE PRODUCTION DEPARTMENT: STORE-ROOM MANAGEMENT.

IN equipping our modern factories with machinery, we are always endeavoring to obtain such tools as will do the work most rapidly and economically. Architects and consulting engineers devote much attention to the best arrangement of power-plant and tools. But the location and arrangement of store-rooms has not received the attention that it deserves.

In glancing over the files of technical publications it will be easy to find a number of descriptions of recently-constructed and "perfectly"-equipped factories, in which not a word is said about the store-room. This used to be true of the drafting department, but with the evolution of the machine shop the drafting room has begun to receive the consideration it deserves regarding its location and equipment. Not so the store-room. Poor store-room management is frequently the cause of delays which entail more loss—and loss which can be more cheaply remedied—than that caused by old-fashioned tools. It is not uncommon to find the store-room in a large factory run by small boys, and with very little evidence that its conduct is characterized by system and order.

If the factory occupies several floors it will be decidedly an economy to have, so far as possible, all supplies needed on any one floor in a store-room on that floor. I have in mind a factory where the elevator was kept going all day long carrying goods to, and distributing material from, the store-room, which was on the top floor. Every workman who needed material was compelled to go up the elevator, and if he wanted two inches of steel, he was given a long bar, which he took down to the first floor, and after cutting off his two inches, he had to take the remainder of the bar up to the top floor again. At the same time, this concern was spending liberal amounts for the purchase of modern machine tools.

Prof. Diemer's papers began with the issue of THE ENGINEERING MAGAZINE for June, 1900. The preceding articles have been:

The Systematized Classification of Shop Orders.
The Production Department: Bills of Material.

If the factory is altogether on the ground floor, as is coming to be the almost universal practice, and a single long room is used for store-room purposes, this room should have more than one delivery window. The stock should be so arranged that a man at the east end of the factory does not have to walk to the west end of a long store-room to get his material. Every few seconds' walk thus saved amounts to many hours in the course of time. For similar reasons of economy, a forty-cent-an-hour man should not be kept waiting at the store-room window until a five-cent-an-hour boy sees fit to climb down from the top of some shelf where he is rummaging. The man who has charge of the store-room should have his headquarters in the store-room and not in the general office. If there is but one large store-room with several delivery windows, there should be push-buttons at each window with an annunciator at the store-keeper's desk, so that he may instantly know of any inattention by the repeated calls from the window where the neglected applicant is waiting.

It is the general rule that castings, instead of being put into the store-room, are piled up on the machine-shop floor; and as orders accumulate and get ahead of the capacity of the shop, more castings keep coming in until there is a perfect wilderness of them piled about, through which the truck-boy winds his tortuous way, and over which men and officers climb and stumble. These castings are piled and repiled from place to place. Frequently their only identification is by means of chalk numbers marked on them at their arrival, indicating the pattern and order numbers. These chalk-marks soon wear off, and when a machine is to be built a committee of experts has to be called in to find the various parts. Pattern numbers are best cast on pieces wherever it is possible. If it is found desirable to mark castings with order numbers, these numbers are best painted on the casting, for tags and chalk marks are soon lost.

It has been suggested that the overhead carrying of pieces by means of an electric crane obviates any difficulty that may be caused by floor passages being obstructed by castings. But it is poor economy to employ a crane of many tons' capacity to carry a mite of a casting, simply because floor passages are blocked. There are arguments for and against the keeping of castings in a store-room. Where storage room can be found for them, so located that they can be reached easily by a crane, there is no question but that it is best to provide a store-room for them, even if it is necessary to make an extension of a building for that purpose, running a continuation of the crane tracks on into the extension.

Where the factory is divided into departments or sections, as has been suggested in a previous paper, it will frequently be found that section store-rooms are extremely advantageous, since they save much walking and enable the foreman of each section to be of considerable assistance on account of his being close at hand, and accordingly familiar with the contents of the store-room for his particular section. Tools should by all means be kept in a tool-department store-room separate from that devoted to general material.

In the scheme outlined in the paper on "Bills of Material," it has been assumed that it is the duty of the material clerk to see that sufficient material is in stock, or ordered, to provide for orders in hand. In a small establishment, the duties of material clerk and store-keeper may be combined and given to one person. The importance of not allowing the store-room and bill-of-material work to get behind should not be under-estimated, however, and the expediency of having two distinct men for the respective offices should be given the most careful consideration.

The question of how much excess stock should be carried, over and above the actual requirements for orders in hand, is one which should frequently be taken up and considered by the store-keeper in connection with the purchasing agent. Fluctuating prices and possibility of delays in delivery enter into this consideration.

I have seen several attempts made to employ the card system in keeping track of stock on hand in the store-room, each card representing a particular size of some certain article, deductions being made for stock applied to orders in hand, and additions being made as new stock is received. But in the experiments tried the cards did not tell the whole truth, since some material is bound to be lost in the processes of manufacture, and the card-balances did not tally with the actual balances in the store-room. The introduction of the card system for this purpose is hardly to be advocated, for the actual material is the only safe record of what is on hand, while the bills of material serve to check off material required for orders.

It is desirable to set aside all material which it is known will be required for orders in hand. This may be done in several ways. One method which has been tried, but which is not likely to prove practicable in many cases, is to provide a number of large drawers in the store-room, and put all the smaller parts required for any one shop order into one of these drawers. A method more widely used is that of marking with tags all pieces allotted for certain orders, but keeping them together with all the rest of the same kind of stock. In order

that this system be successful it is necessary that strict discipline be maintained over every store-room employee, and the severest punishment should be inflicted on anyone applying stock marked for one order on any other order.

In devising shop systems there is always danger of carrying systems to extremes. Where forms are not needed they should be avoided. Thus it is quite apparently unnecessary to set aside and mark for certain orders such material as can be immediately obtained at a moment's notice, such as cap screws or machine screws of standard sizes. The store-keeper should make it his business to see that a reasonable surplus of such standard stock is always carried on hand, over and above all possible requirements. The inspection of the actual stock on the shelves and in the drawers must not be left to boys, but should have the frequent and close attention of the store-keeper personally.

A practical method of accounting for material drawn from the store-room is by means of "Material Slips" signed by the section foreman. A form in use where this method was employed, is given below:

MATERIAL DRAWN FROM STORE-ROOM.

SECTION..... **DATE**.....

Shop Order	For what part of machine	Material	Quantity
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....

.....Foreman.

In this system a separate slip is used for every separate order number. Each day's slips are sent in to a clerk who arranges them according to order numbers, and then posts in the bill of material, opposite each item as specified therein under the column "Material Used," the date and the amount of material drawn. Each day's material slips, after having been posted, are fastened together by a fastener and stored away in some place easy of access. The importance of posting the date is apparent, because if it is necessary to investigate why discrepancies appear between the amount of material specified and the

amount actually used, the original material slip is easily located by means of the date.

It is desirable that all material of one kind for any one order be drawn from the store-room at one time. But this is not always feasible. For one machine, or perhaps several machines, on an order may have to be rushed through and finished months before the rest of the machines on the same order are completed.

A part of a bill of material with the postings made on it, is herewith given. In the example given, the order calls for eight machines. The material postings show that two of the machines were built about four weeks in advance of the remaining six.

In the case of some few kinds of material the issuing of a small excess of material may be unavoidable, and in such cases, when the unused excess is returned, a "Credit" notation is made on the bill of material, as is shown in the micanite used for the commutator sleeve in the example given for illustration. Such credit entries are made prominent by posting them in red ink. Where the material slips are used for drawing material from the stock-room a "Credit" material slip on a different color of paper is used in returning such excess material to the store-room.

In a large establishment where the above system had been used for some years, it was found that the process could be much simplified by the complete abolishment of the material slips. In their place the original bill of material belonging to each section was used. For instance, if a man from Section "A" desired material from the store-room for Order "2930", he went to the foreman of his section, was given Section A's bill of material and carried this bill of material to Section A store-room. Here the store-keeper gave him the material desired and posted it direct on Section A foreman's copy of the bill of material and also on has own copy of the bill of material. It was found that with this system the reasons for overdrawing material had to be explained before the material was over-drawn, instead of afterwards.

If a man has already drawn the material required, it is apparent at once on the bill of material, and if a man in any department wants certain material for an order and sees that it has already been drawn by the notation of that fact on his department's bill of material, he will search in his own department for the material, instead of spending the time necessary to go first to the store-room and there find out that the material has already been drawn, or perhaps be given the excess material and then have the matter come up for explanation

BILL OF MATERIAL.

SECTION *D.*
SHIPPING ORDER, *S 3298.*
SHOP ORDER, *C 876.*
8 MACHINES, TYPE *K 10.*
TO BE COMPLETED *Oct. 10, 1900.*

DATE, *Aug. 6, 1900.*

Article.	Material.	Size or Pattern Number.	Drawing Number.	Quantity.	Date Ordered.	Date Received.	Material drawn from Store Room.	Total Weight.	Cost of Material.	Cost of Labor.
Commutator.										
Sleeve	*c. i.*	2136	4927	8	8/12	8/17–4 8/18–4	8/21 9/15 2-40 lbs. 6-133 lbs.	173	.....	.....
Ring	*m. i.*	2137	4927	8	8/12	8/20	8/21 9/15 2-6 lbs. 6-19 lbs.	25	.....	.....
Nut	*m. i.*	2138	4927	8	in stock.		8/21 9/15 2-8 lbs. 6-25 lbs.	33	.....	.....
Segments	*c.*	911	2117	576	"		8/21 9/17 144-12 lbs. 432-38 lbs.	50	.....	.....
Fil. hd. Screws	.....	½" x 4"	4928	32	"		8/25 9/20 8 24	.....	.....	.....
Nuts	*i.*	½"	4928	32	"		8/25 9/20 8 4	.....	.....	.....
Micanite Segs	.....	1311	2118	576	"		8/21 9/7 144-3 lbs. 432-9 lbs.	12	...	.....
Micanite Sleeve	.....	1411	2634	8	"		8/21 9/17 9/18 *Cr.* 6 lbs. 18 lbs. ¾ lb.	23¼	.....	.....
Micanite Ring	.....	1412	2634	8	"			....	.....	.....

Note: Owing to the size of the page of the magazine this form is necessarily shown on a reduced scale. A liberal width should be allowed in practice to admit of all posting necessary without crowding.

days afterwards when it would be difficult to remember the exact facts of the case.

The giving out of material of any kind in bulk needs to be avoided as much as possible, and facilities should be provided inside the store-rooms for the cutting off of metal rods and bars, fibre, paper, hard rubber, etc., to size, by the placing of hack-saws, band-saws, and cutters inside the store-rooms. If the store-room help spends any continuous time on this work of cutting a quantity of material to size, the time of such help during such periods needs to be charged up to some standing order which will ultimately be charged to Material account, instead of Expense account, to which their time as unproductive laborers would ordinarily be charged.

In tool-rooms, it has been found a good plan in several instances to provide a number of light brass checks, say ten for each employee likely to draw any tools, numbering these with the employee's numbers. When a man draws a tool, one of his checks is hung on a hook provided for that purpose in the place of the tool; or in the case of a tap or die or similar small tool, the check is laid in the recess usually filled by the tool itself. The disadvantage of this system is that the machinist is at the mercy of the clerk in the tool-room, who may carelessly put his check in the wrong place. In view of this fact, it is possible that after all a written receipt will in many cases be most satisfactory, the receipt to be returned to the machinist immediately on his return of the tool in good condition.

Labor done in the tool room will of course be properly charged to the standing order for new standard tools, or to the one for repairs to tools, or, in the case of special tools for certain orders, to the particular order for which such tools are made.

The next article will deal with the practical working of the production department in the execution of the work.

APPLICATIONS OF ELECTRICITY IN THE COLLIERIES OF GREAT BRITAIN.

By Sydney F. Walker.

THE general conditions of working appertaining to a colliery, so far as concerns the work to be done and the power appliances to be used, are of course very similar to those attending metalliferous mining. In order to obtain the coal or ore, except at surface outcrops or where it lies under the mass of a mountain but above the level of the valley beneath, shafts are sunk from the surface into the bed of the lowest seam or deposit that it is intended to work.

In each seam roads are made, in the mass of the coal itself, from the shafts, in various directions, within the area for which a lease has been obtained. In each coal basin a number of mines are worked, each having a certain area of ground below the surface from which the mineral may be taken, and each having also a certain small area surrounding the top of the shafts, within which the engine houses, offices, and other necessary adjuncts are placed.

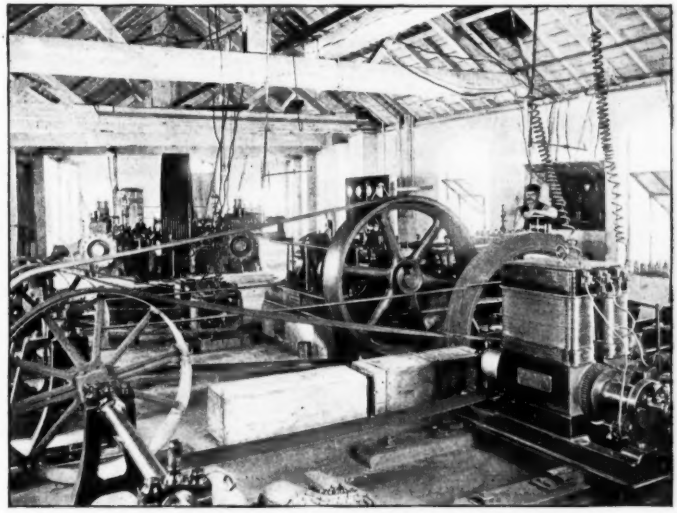
There are various methods of working, or obtaining the coal, the principal being those termed "pillar and stall" or "bord and pillar," and "longwall." In pillar and stall working, pillars of the coal are left as the work proceeds outwards from the shaft, the object being the support of the strata above, and when the mine has been worked to its boundaries, "working back" towards the shafts commences, all the pillars being removed as the work progresses inwards.

In longwall working the coal is either worked steadily outwards along a long face from the shafts towards the boundary, or, the roads being driven to the boundary, the coal is worked back along a long face towards the shafts. Longwall working is, I believe, gradually displacing other methods in all the coal fields in the United Kingdom.

In either case the miner has to "get" the coal, either with his pick, by blasting, by a coal-cutting machine, or by other means, and to load it into small mine wagons or trams, as they are usually called, holding from 10 hundred weight to 30 hundred weight. When loaded, the

The manifest advantages of electric applications in mining are so rapidly extending its use that even a closely condensed review exceeds the limits of a single article. Mr. Walker's interesting discussion will be continued in the September issue of THE ENGINEERING MAGAZINE.—THE EDITORS.

trams are hauled to the shafts, either by horses or by mechanical power. There they are run on to the cages, which are hauled up and down the shaft by means of ropes from the winding engines on the surface. There the coal is weighed, the number of the miner who filled each tram is noted, and the tram itself is run off to the "coaling" screens, where some method is arranged for separating the small coal from the large, and for removing the foreign matter, shale, stone, etc., which is present with all coal, and for loading into the railway trucks.



ELECTRIC GENERATOR HOUSE, TRAFALGAR COLLIERY, 150 HORSE-POWER COMPOUND ENGINE AT THE BACK.

In addition, the successful working of a coal mine necessitates the constant removal of the rubbish which has to be "got," either in making roads or in getting the coal—the foreign material which exists above and below, and is often found dividing, the seams of coal.

All of those working in the mine, also, have to be provided with air and with light, and in certain portions of the mine special precautions have to be taken that the light furnished shall not be able to ignite an explosive mixture of carburetted hydrogen gas and air, such as is often met with.

Further, nearly all mines are very much troubled by the presence of large quantities of water, in portions of their workings, which must be removed.

Into all of these operations—cutting the coal by machinery, drilling holes in the coal or the rock for blasting, firing the shots, hauling the coal from the working face to the shafts, signaling to the haulage engine from any portion of the haulage road, signaling to the winding engine, communicating between the overman's cabin in the mine and the office, pumping the water from the lower portions of the mine, directing the air current to different portions of the mine, hoisting trams up small "staple" pits from one seam to another, working the moving coal-screening gear, lighting the mine, the surface, the engine houses, the offices—into the working of all these, electricity now enters very largely, and will enter more and more as its great economical advantages are better understood. I believe that the time is not far distant when not only will the steam plant of the colliery be centralised at a main electrical generating station, but one generating station will often supply a group of several collieries.

Where coal is to be brought down by blasting, a hole about 1½ to 2 inches in diameter is drilled several feet into the coal, in a position chosen by the miner as one in which the explosive force of the charge will be most effective in bringing down the coal and in breaking it up into pieces of convenient size for filling into the trams. The charge was fired, in the old days, by a damp straw filled with powder, which was lighted by a miner, who then got himself out of the way. Later this was superseded by the safety fuse, which burnt at a certain rate. Many accidents arose with these methods of firing, owing to men going back to their shot, supposing it to have missed fire, and the charge then igniting.

This danger has been overcome to a large extent by not allowing the shot firer to go near his shot for a certain time after he has ignited the fuse, but mines inspectors and mining engineers are now all strongly in favour of firing by electricity, as being absolutely safe and involving no waste of time.

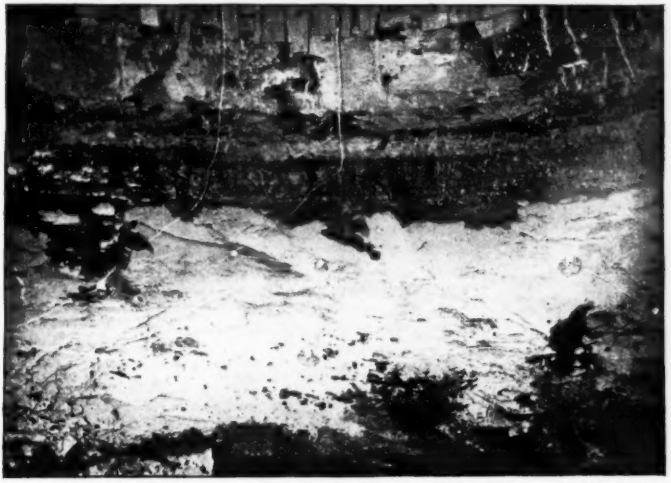
When electricity is employed for firing the shot, an electric fuse is inserted in the charge, having two thin insulated wires connected to it. The wires are made long enough to project a few inches beyond the shot hole. Sometimes two, three, or more shots are fired in the same number of holes simultaneously, and in those cases the wires of the fuses are connected together, so that the current from the electric generator may pass through all the fuses at once.

The fuses are of two kinds, arranged to fire either by the heat generated by the passage of an electric current through a small platinum wire, or by means of the heat and detonating action of a spark passing

between the ends of two copper wires. In both cases the wire or wires are embedded in a small quantity of a detonating substance, such as fulminate of mercury, which is able to generate sufficient heat to ignite the charge.

The fuses with small platinum wires which become hot on the passage of a current are known as low-tension fuses, and the current for them is furnished either by a magneto-electric generator, usually called an exploder, arranged for currents of low pressure but of comparatively large strength, by stationary batteries of galvanic cells placed in any convenient positions near the face, or by a small battery of small cells carried in a box which may be slung over the shoulder.

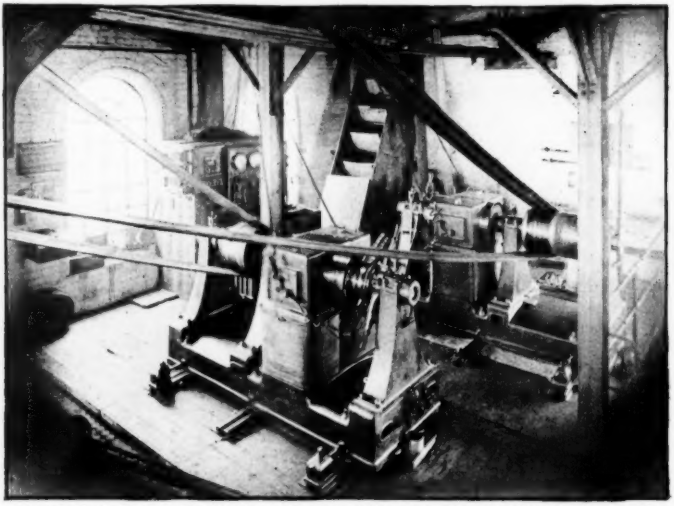
The fuses which fire by means of a spark are known as high-tension fuses, and current for them is furnished by an electrostatic induction machine, or by means of the far handier small magneto-electric machine. This apparatus is constructed with permanent magnets and a shuttle armature, the whole contained in a box, with a leather strap



A FACE OF COAL WITH WIRES FOR FIRING ELECTRICALLY SEVERAL SHOTS AT ONCE.

to pass over the shoulder, a handle to turn the armature, and a small push which is pressed when the shots are to be fired. When required for high-tension fuses, the armature of this exploder is wound with very fine wire; when for low-tension, with coarse wire. Arrangements have been made to ignite electric fuses from the electric-lighting service of the mine, by leading the twin wires to the electric light service through a firing key, but in my opinion the plan is very unwise.

For drilling the holes in the rock or coal, electric drills are employed, which consist of a drill driven by gearing for reducing the speed of rotation, a small electric motor engaging with the last wheel of the train and providing the power required. The motors are supplied with current either from the existing service at the mine or by a



ELECTRIC MOTORS WORKING LUHRIG COAL WASHERY AND SCREENS, ACKTON HALL COLLIERY.

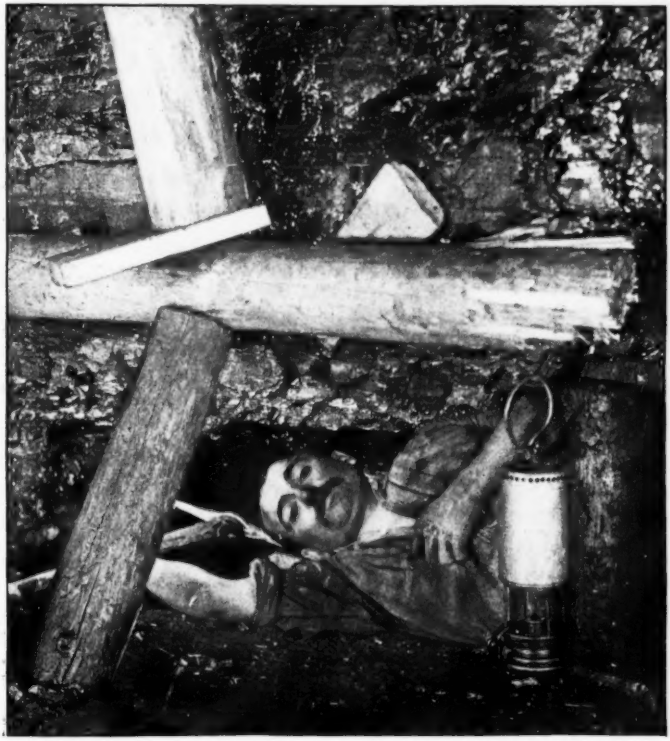
The two motors work onto one countershaft. Either alone is capable of the whole work.

special plant—usually the former. The supply cables are brought to some convenient spot in the neighbourhood, where an enclosed connecting box is fixed, and flexible cables are taken from there to the motors. Current for the lights is taken from the same service. The electric drills take from 2 horse power to 8 horse power, according to the nature of the material to be drilled, and the current, which varies in strength inversely as the pressure, is supplied at pressures ranging, at the surface, from 200 volts to 500 volts, and at the drills, from 200 volts to 430 volts.

Another method of utilising the convenience and economy of transmission by electricity, which is employed on the continent of Europe, is as follows: The rock drills are driven by compressed air, but the air is compressed at some convenient spot close to the face of the workings, the energy required for compressing the air being transmitted from the surface by electricity. The compressed air is conveyed to the drills by flexible pipes in the usual way. It is a question

which can only be decided by actual figures in each case whether anything is gained by this method. An additional conversion of energy, and a somewhat wasteful one, is introduced in the transmission line. The German firm who supplied the plant, however, state that they get a better result than by using electricity all through.

Coal Cutting by Electricity.—The work required from a coal-cutting machine of any kind is the cutting of a channel in the rock under thin coal seams, or in the coal itself in thick seams. In days gone by thin seams were worked by special thin coal miners, who worked in a very awkward position, requiring a special training to enable any work to be done, or any money to be earned. The continued lowering of the price of coal, however, together with the generally increased rate of wages and the gradual extinction of the old-time coal miner,



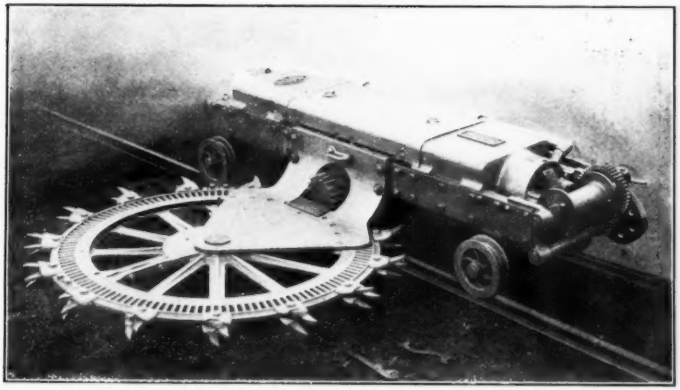
UNDERCUTTING OR "KERVING" COAL BY HAND, THE OLD METHOD NOW BEING SUPERSEDED BY THE USE OF COAL-CUTTING MACHINES.

owing to various causes, has rendered hand getting of thin seams commercially impracticable, and so the machine for coal-getting first came into use. But it was soon found that where a machine could be employed, even in thick coal seams, it got the coal in a better form and at a cheaper rate than hand labour, and so the coal-cutting machine is gradually being generally adopted.

Coal-cutting machines have been arranged mainly on two lines. In one form, a disc of iron or steel carries on its periphery a number of cutters, which can be removed for sharpening. The disc is held in a framework, and is actuated by gearing, which is again set in motion by some form of mechanical motor. On the framework, also, is usually carried a small haulage drum, which is slowly revolved by the gearing, hauling the machine along as the cutting proceeds. The early forms of the disc coal-cutter were necessarily driven either by steam or by compressed air (usually the latter), because at that time electrical motors were not far enough developed to be used for the purpose. But as soon as the electric motor became a sufficiently practical apparatus, it was a very simple matter to substitute such a motor, properly protected from the danger of ignition of gas by the enclosure of all parts within an iron case.

DISC COAL CUTTER AT WORK.
Courtesy of the Diamond Coal-Cutter Co.

The coal-cutting machine is placed longitudinally in front of one end of a long face or wall of coal, previously prepared, the machine being on rails laid for it, and the haulage rope taken out and secured at the end of the face. The cutting disc lies very close to the ground, and when first fixed a place is cut for it by hand to the depth under the coal of nearly half its own diameter. When everything is ready current is allowed to pass into the motor coils, the disc revolves, cutting the channel under the coal, and being pulled forward as it cuts by its own haulage drum. As the electric motor runs at a much higher speed than the engines it displaces, gearing has to be arranged between the shaft of the motor and the axle of the disc; but there is plenty of room for this, owing to the displacement of connecting and eccentric

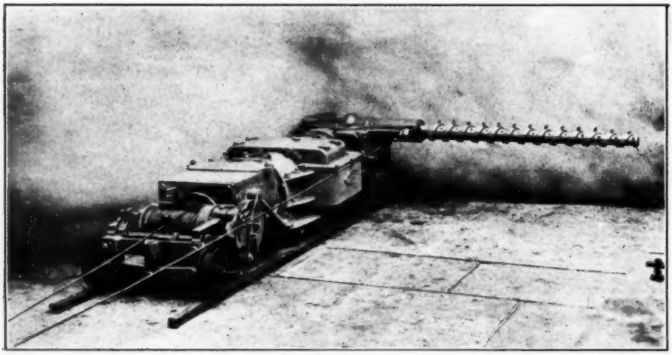


COAL-CUTTING MACHINE WORKED BY TWO THREE-PHASE MOTORS, ONE EACH SIDE OF THE CUTTER DISC.
By the Diamond Coal-Cutter Co.

rods, etc. The gearing is contained principally within the iron box, and consists either of a train of wheels, or worm and wheel, the axle of the motor being geared to one end of the train and that of the disc to the other end.

Another form of coal-cutting machine which has been introduced by the electrical firms who have taken the matter up, and which has not I believe, been driven by any other physical agent, is the bar coal-cutter, shown on page 720. In this machine a bar, slightly tapering outwards, takes the place of the disc, movable cutters being placed in circles round the bar. There are two forms of this coal-cutter, one known as Goolden's, in which the bar is held rigidly when it has once assumed the position perpendicular to the coal face; the other, known

DIAMOND COAL-CUTTER DRIVEN BY TWO CONTINUOUS-CURRENT MOTORS, ONE ON EACH SIDE OF THE CUTTER DISC.

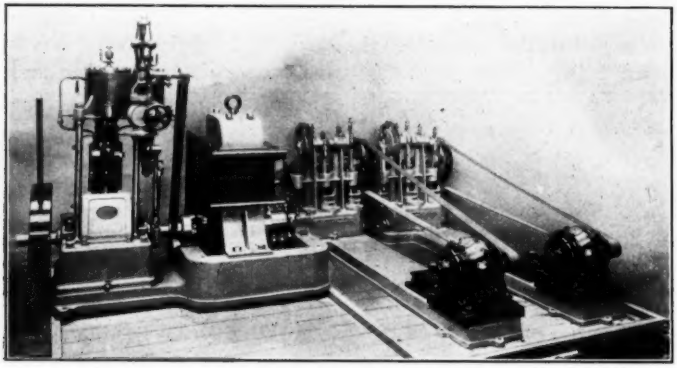


HURD'S ELECTRIC COAL CUTTER.

A taper bar is used, provided with moveable steel cutters. By Mavor & Coulson, Ltd.

as Hurd's, in which the bar is able to ride up, if it meets with a piece of very hard rock, which the power at the disposal of the motor will not enable it to cut through.

Two other forms of electric coal-cutting machines are known in Great Britain—the Jeffrey chain cutter, and the Jeffrey coal shearer. In the chain cutter, which is principally used for driving headings, an endless chain with cutters attached works round a long frame, and receives motion through gearing from an electric motor carried on the frame. The front of the machine with the chain is pushed up against



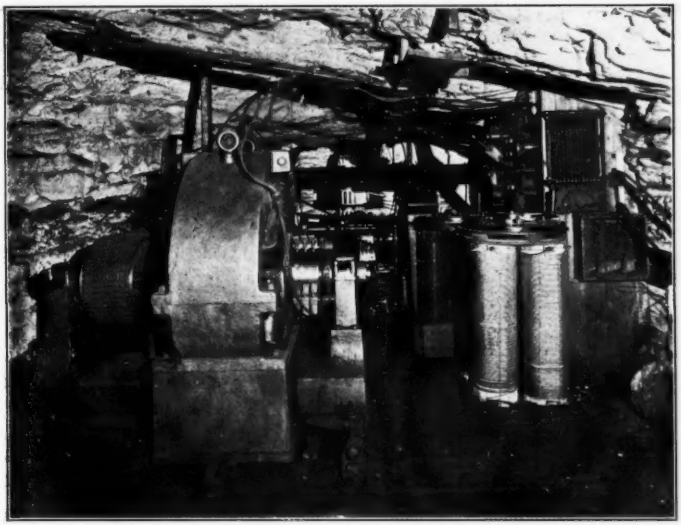
ELECTRIC PUMPING OUTFIT FOR NORTH OF ENGLAND COLLIERY, CONSISTING OF ENGINE DIRECTLY COUPLED TO DYNAMO, WITH TWO SETS OF THREE-THROW PUMPS BELT-DRIVEN FROM THE MOTORS.

By Ernest Scott & Mountain.

the face to be cut, and the chain works round, cutting as it goes, the frame following the cut as it is made.

A modification of this chain cutter is the bar cutter, in which a bar fitted with moveable cutters is held in a horizontal position, in front of the frame, parallel with the coal face, and revolves horizontally, cutting as it revolves, the frame following it. The shearing machine is virtually the horizontal chain cutter arranged to cut vertically instead of horizontally. It is also arranged to cut at different levels, so that a continuous cut of several feet may be obtained.

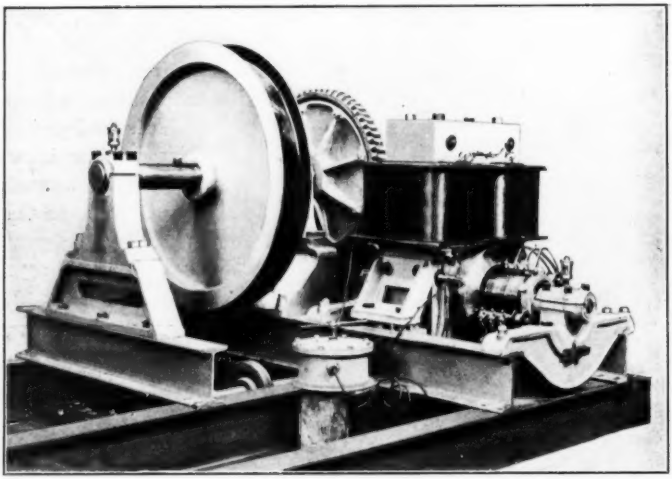
The iron box containing the electric motor in all coal-cutting machines also carries the switching and starting gear.



UNDERGROUND ELECTRIC HAULAGE POWER STATION FOR ENDLESS ROPE AT ACKTON HALL COLLIERY; SHOWING STARTING GEAR, RESISTANCES, ETC.

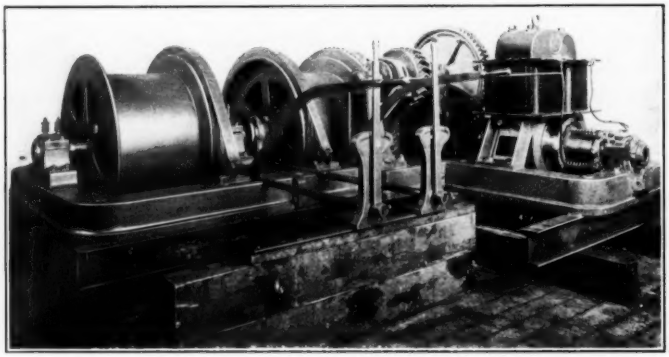
The motors of coal-cutting machines are fed from the electrical service of the colliery by means of cables brought to a convenient point, where a connecting box is usually fixed, and flexible cables lead from it to the machine, lights being taken from the same service. In a few cases, special generating plant has been put down for coal cutting only.

Coal cutting by electricity has not found as great favour in the United Kingdom as in America and on the Continent, and principally, I believe, because the pioneers in the work very much underestimated



ENDLESS-ROPE HAULAGE GEAR WITH ONE ROPE PULLEY, DRIVEN BY ELECTRIC MOTOR THROUGH WORM GEARING.

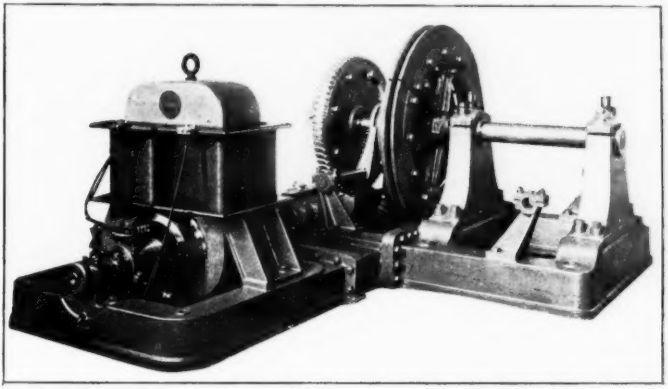
the amount of power required. Further, the motor used to drive a coal-cutting machine stands at a considerable disadvantage with reference to the engine using steam or compressed air, from the fact that, in the event of the cutter sticking fast, considerable damage may be done to the electric motor by its coils heating, where the engines would suffer no inconvenience beyond the stoppage. The remedy, of course, is the use of larger and more powerful motors. The power required for operating a coal-cutting machine varies necessarily with the



ELECTRIC MAIN-AND-TAIL HAULAGE PLANT, DRIVEN THROUGH GEARING.

hardness of the coal or rock to be worked. For some of the softer coal seams, as little as 12 horse power is sufficient, while in other cases as much as 30 horse power may be required, and even 50 horse power has been provided in some cases. These powers are delivered to the motor, and include the charge for conversion within the motor itself and for gearing, but not that for the loss in the cables leading from the generators. The current strength required will be inversely in proportion to the pressure delivered at the motor.

Mine haulage in Great Britain, with a few exceptions and with occasional modifications, is arranged on one of two principles—the

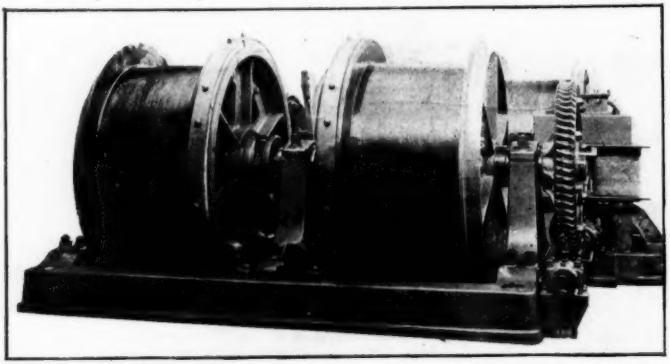


ELECTRIC-DRIVEN ENDLESS-ROPE HAULAGE GEAR, WITH CLIP PULLEY.
By Ernest Scott & Mountain.

endless-rope or endless-chain system, and the main-and-tail system. In the former, as the name suggests, the rope runs from the driving engine out along one set of rails, around a pulley at the extreme end, and back along the other set of rails. Loaded trams coming from the mine, or empty ones going in, are attached to it at any desired point by a suitable form of clip. The travel of the rope is continuous, motion being imparted to it either by a clip pulley or a friction pulley, which under the old steam practice was usually placed on the crank shaft of a pair of engines. All that was necessary to convert an endless-rope hauling engine to an electrical hauling engine was the substitution of an electric motor with the necessary worm or wheel gearing for the pair of engines, the pinion on the axle of the motor engaging as before, with the last wheel of the train, or the axle carrying the worm.

In the main-and-tail haulage system usually only one set of rails is provided, and the same rope brings the full trams out from the coal

face to the pit bottom and returns the empty trams to the face. The rope, though in one, is really two ropes formed into one, *viz.*, a main rope which pulls the full trams out, and a tail rope which tails after the full trams, and which then becomes the haulage rope to pull out the empty trams. The main and tail ropes are wound in, each onto its own drum, which drums—before the advent of the electric motor—were usually driven by means of a pair of engines and gearing. With



MAIN-AND-TAIL HAULAGE GEAR, ELECTRICALLY DRIVEN THROUGH WORM GEARING.

electric main-and-tail haulage, motion is communicated to the drums by means of the electric motor and gearing, the axle of the motor, as before, carrying the worm, or the pinion which engages with the last of the train; or the motion may be communicated from the axle of the motor, by means of a belt or ropes, to a first motion shaft, and from thence to the haulage drums. This last method has the great advantage that it relieves the armature of the motor of the heavy initial strains on starting. With electrical haulage, whether endless-rope, or main-and-tail, one essential difference from the engine-driven haulage is necessary, *viz.*, the switchboard.

There are various modifications of these two systems of haulage, arranged to suit the special arrangements of different mines, but the arrangement for the adoption of electric motors in place of steam or compressed-air engines remains the same.

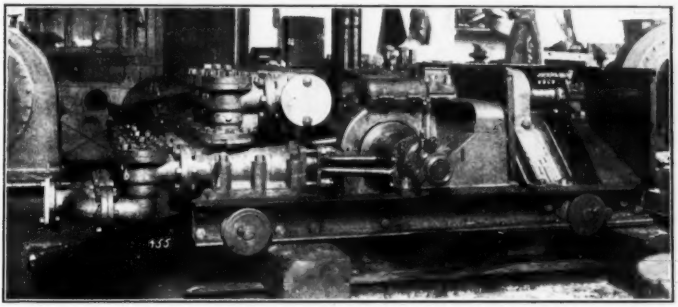
Secondary Haulage.—Where the mine is large, the area of the lease being extensive, and the endless-rope system largely employed, what is termed secondary haulage is also used. Out of the main engine road branch several smaller roads leading to the coal face, and it is from these smaller roads that the endless rope on the main-engine plane is fed.

In a great many mines the secondary haulage is worked by ropes driven by pulleys, which are again driven by the main haulage rope, a mechanical clutch giving command of the gear. In some cases, however, electric motors have taken their natural place, and are used to work these secondary haulage roads.

There is another form of electric haulage, very much used in mines on the continent of Europe, in which an electric locomotive hauls a journey of trams from the face of the coal. The locomotive is worked by means of a current obtained from an overhead trolley wire, being merely a truck carrying a motor, starting and stopping gear, and measuring instruments. I believe that this system is used almost entirely on what are termed "levels" in Great Britain, in which the mine consists of a tunnel running into the side of a hill. The electric locomotive haulage has been in use in the Laukeroda mine in Prussia for nearly twenty years past, an angle iron on the side of the tunnel taking the place of the trolley wire.

Pumping by Electricity.—The water in the mine may be dealt with in two ways, according to how the coal beds lie.

Where the coal dips from the shaft, the face of the coal will be the lowest part of the mine, and any water there may be in the mine will gravitate there.



HORIZONTAL THREE-THROW PUMP, WITH ELECTRIC MOTOR MOUNTED ON SAME CARRIAGE, FOR USE IN DIP WORKINGS.

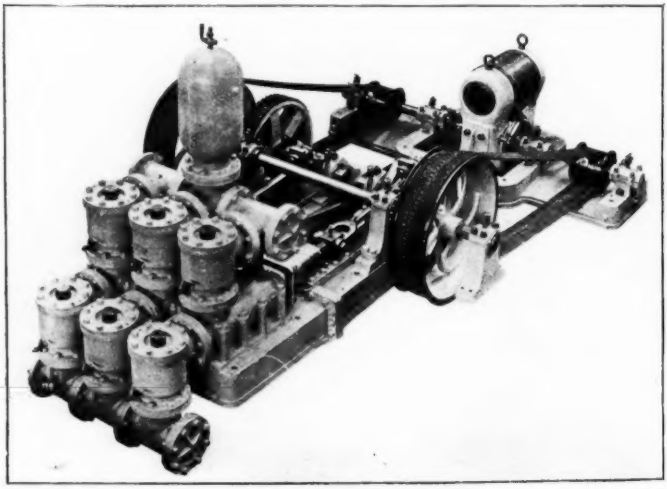
By Ernest Scott & Mountain.

As the face of the coal is constantly moving onward, and downward, the water following it, the pump and electric motor are usually mounted on one carriage, of wood or iron, on which are also mounted drums for the cables and the switching and starting gear. The carriage or truck is placed on wheels, mounted on the rails, and follows the face and the water as it advances.

The other method of dealing with the water in a mine is to allow it to drain into tanks or chambers, either at the pit bottom or at various portions of the mine, and at these stations placing a pump and motor of the size required. In these cases a chamber is formed in the coal, lined with timber or brick, and in it the pump, motor, and switching gear are placed, the pump and motor now being fixed on firm foundations and the switchboard on one of the walls of the chamber.

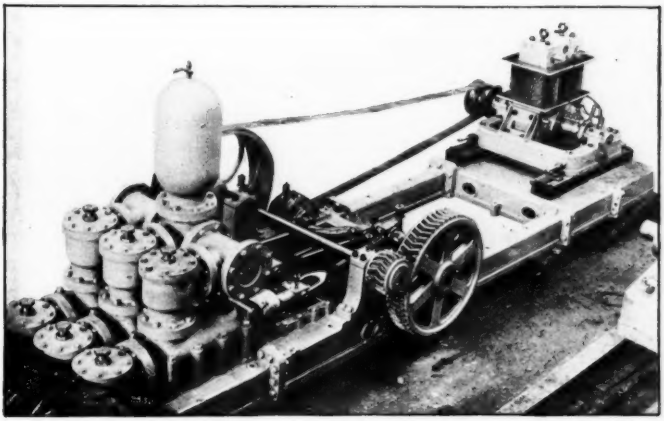
The power required to be delivered to the motor working an electric pump necessarily varies with the quantity of water raised, the height it has to be forced, and the length of pipes through which it is forced.

One very beautiful adaptation of electricity for mine pumping, which is also of great service for other purposes, is the ability to stop or start the pump without anyone going near it. It often happens that a



THREE-THROW RAM PUMP FOR DIP WORKINGS, BELT-DRIVEN BY ELECTRIC MOTOR, THE WHOLE MOUNTED ON ONE BED PLATE.

pump is placed either in an out-of-the-way spot, or at some distance, while it may be required to work only a few hours, more or less, each day, according to the water present, and it is desired to avoid the expense of having an attendant there constantly. Also, if a pump is left by itself, some of its bearings or those of the motor may get hot, causing so much extra friction that the motor cannot overcome it, and stops, possibly being seriously damaged in the process.



ELECTRIC DIP PUMP ON CARRIAGE, WITH BELT AND WHEEL GEARING.
By Ernest Scott & Mountain.

To avoid this an apparatus very much like an old telegraphic relay is employed. It consists of an electro-magnet of the usual form, whose coils are included in the circuit supplying current to the pump motor. The armature, when the pump is working normally, occupies a certain position. If from a hot bearing or any other cause the motor stops, instantly the armature is attracted to the poles of the magnet, and completes a local circuit which throws open the pump switch. For the reverse operation, when the pump has no work to do, all the water having been pumped out, or the equivalent, and the motor is running away, the current passing to the pump being so weakened the armature falls back, again completing a circuit which opens the pump switch.

THE FUTURE OF POWER DEVELOPMENT.

By William D. Ennis.

MR. GEORGE WESTINGHOUSE was probably the first to formulate the theory that more saleable energy results from an electric-generating plant in which the dynamos are driven by gas engines, than from one in which the motive power is steam, resulting from a combustion of the same amount of coal requisite to produce the gas consumed in the former case. Mr. Alton D. Adams, writing in the April number of THE ENGINEERING MAGAZINE, demonstrates that a producer-gas plant having a combined efficiency of 20 per cent. will show a saving of 39.4 per cent. of the coal required for a highly economical steam-driven plant carrying the same load.

The reciprocating steam engine, of which the fundamental formula was deduced by Carnot, represents the mechanical progress of a century, and exemplifies in its history the beginnings of scientific engineering. In Professor Thurston's recent paper,* read before the American Society of Mechanical Engineers, a *résumé* of this history is given, showing from what small beginnings have been developed the almost universal prime mover of to-day, with its efficiency only 16 per cent. short of that of the ideally perfect engine of its class. It might be expected that the author of this monograph, after having so aptly described a century of progress, would be justified in indulging in some words of gratification. What the writer does say, however, is as follows: " . . . the field of the steam engine will become greatly restricted by the introduction of other heat motors . . . by the employment of electricity . . . from hydraulic and pneumatic prime movers. The steam engine has now been so far perfected . . . that but little more can be expected of the designer; and even with the costlier types of engine . . . commercially practicable progress seems likely to prove very slow henceforth."

Every method of obtaining power depends on a series of transformations applied to some material or force supplied by nature. One of the simplest of these series is in the case of a wheel turning by the force of a waterfall. In an electric steam-driven power plant, we have: (1) Combustion of the coal, (2) evaporation of water into steam, (3) expansion of steam in a closed cylinder, causing a straight-line motion of a moveable piston, (4) transformation from a straight

* Trans. A. S. M. E., No. 833, Vol. XXI.

line to a rotative motion, (5) generation of electrical currents due to this rotative motion of conductors in a magnetic field—or five transformations in all. In a producer-gas-driven plant of the same kind, there are two initial series of transformations, culminating in one result. The auxiliary series consists of: (1) Coal combustion, (2) evaporation; and at this point is joined to the main series, after its first step. The main series is (1) moderate heating of coal, (2) combination with the component gases of steam, (3) (neglecting enriching processes), ignition and explosion, (4) rotary motion, (5) generation of current. The number of transformations in the main series is five, in the auxiliary series two. The furnace coal is an item of much more consequence than the boiler coal from a financial standpoint, and the additional auxiliary item may be ignored in comparison, so that the total number of changes is practically five, the same as in the case of a steam-driven plant.

From a purely theoretical standpoint, assuming that all transformations are equally efficient, gas possesses no superiority over steam. The general equation for resultant efficiency of any motive force is x^a, where x is the efficiency of each transformation, and ^{a} is the number of transformations. For this reason, a turbine-driven dynamo will give a greater pro-rata output than one steam driven, in the ratio of x^3 to x^5. Moreover, even when the varying values of x are considered, it is obvious that the gas-driven plant, with its exponent of ^{5}, can never compete with a hydraulic plant having an exponent of ^{3}.

Obviously, the only method of increasing the output in any given series is to increase the value of x (which is always less than unity), or to decrease the value of ^{a} by eliminating one or more steps from the process. In the case of a steam engine, driving an electrical generator, assuming the efficiencies of the various steps in the series to be 0.80, 0.9375, 0.15, 0.90, and 0.95, respectively, the value of x^a is equal to their product, or 0.096—less than one-tenth of the initial coal energy being utilized. The value of ^{a} cannot be diminished, and that of x is capable of only a limited increase. The utmost attainable values of the factors above given are probably 1.00, 1.00, 0.35, 1.00, and 1.00, the product being 0.35, which is the ideal value of x^a. An attainable output equal to over one-third the coal energy would result, or over three times the output under present conditions.

In a gas engine, the Carnot cycle, with an efficiency of possibly 0.35 under conceivable ranges of pressure and temperature, is generally replaced by the cycle of Beau de Rochas. This is applicable to internal-combustion motors only, and gives but one impetus to the pis-

ton in every four strokes. Pressures of more than 300 pounds to the square inch are met with, which gives an advantage, both theoretical and practical, over the ordinary steam engine. Thermal efficiencies, from gas to electrical output, of 13 per cent.* are reported even for engines as small as 125 horse power. For larger units, 20 to 25 per cent. efficiency is claimed.†

No comparison between the steam engine and the gas engine is just which does not take into account all the transformations, from raw material to finished product. It is true that a manufacturer may frequently be ignorant of the cost of the raw materials of his trade, those materials reaching him in a partially completed form. If we know the cost of steam and the cost of gas, it appears a simple matter of arithmetic to determine the most economical form of power. Unfortunately, we do not know the cost of steam, nor of gas, in a scientific and accurate way. For every case, these costs differ; and in every case there is some factor in their production that is not manifest in the statement of that cost, but which may yet have an important bearing on the remaining transformations and on the final value of x^a.

An expert, in analyzing such costs, would probably group them about general headings like the following:

INVESTMENT (A).

THE STEAM ENGINE.	THE GAS ENGINE.
Real Estate.	Real Estate.
Buildings.	Buildings.
Boilers.	Boilers.
Boiler Setting.	Boiler Setting.
Flue and Stack.	Flue and Stack.
Piping.	Piping.
Auxiliary Machinery.	Retorts.
Engines.	Holders.
Condensers.	Gas Piping.
	Auxiliary Boiler Machinery.
	Auxiliary Gas Making Appliances.
	Gas Engines.
	Mufflers, etc.

OPERATION (B).

Coal for Boilers.	Coal for Boilers.
Water for Boilers.	Water for Boilers.
Oil.	Oil.
Water for Condensers.	Cooling Water for Engines.
Labor.	Coal for Retorts.
	Naphtha, etc.
	Labor.

* Trans. A. S. M. E., No. 835, Vol. XXI. † THE ENGINEERING MAGAZINE, April, 1900

GENERAL OPERATING EXPENSES. (C).

Interest.
Sinking Fund (Depreciation).
Taxes and Insurance.
Superintendence and Expense.

Added to these factors there are several others, not to be shown on a balance sheet, but of overwhelming importance as governing the final answer to the question of form of power. Some of these will suggest themselves at once.

(1) Safety.
(2) Continuity of service.
(3) Effect on public health and comfort.
(4) Applicability to varying loads and conditions of load.
(5) Effect of location—whether near a central source of supply of steam or gas, or isolated.

Speaking generally, there are to be considered two great factors influencing the costs. The first is location; the second, size of plant. Two conditions are possible, with regard to location; nearness to, or remoteness from, a central supply. The sizes may be distinguished as small, medium, and large. No further exactness is possible, nor can we tell just what capacity limits are covered by these three terms.

First, assume the existence of a plant to be close to a central station. The steam user, whether he be in the small, medium, or large class, will in all probability have his own boilers in preference to buying steam. The gas-engine man, if a small consumer, will buy. For him, A will be proportionately large, and B likewise. He will gain little, if any, in efficiency over the steam user, and will be dependent upon a single outsider for the operation of his plant. If a moderately large consumer, he will be able to buy gas at low rates, but unless the conditions are extremely favorable he will be handicapped in competition with steam by the high cost of his equipment and the consequent high interest charge. If a very large consumer, he will have his own gas-making plant, or will buy gas at an equivalent rate, so that he will obtain the unquestioned advantage of a higher efficiency.

Where the plants are at a distance from a central supply, the small gas man may have a miniature producer, but his first costs and interest charges will be enormous. The larger consumers will pay proportionately less on these accounts, but will have a large and complicated equipment to care for.

In all these instances, there are suggested certain limitations and modifications. First, gas making, even fuel-gas making, is a special process, requiring great skill. This militates against the small con-

sumer in the country. Second, gas from a central station must be carried to the consumer in expensive pipes. This is of consequence to the buyer of gas, be his requirements large or small. Third, the gas engine furnishes no exhaust steam for heating a building during the months when heating is required and the power load is most ample to take care of the heating. This is a point in favor of steam for small city consumers.

As Mr. Westinghouse has pointed out, the relations of this subject with those of garbage disposal and water supply* are of the utmost consequence. It seems reasonable to expect that these relations will result in an immense field for gas in large central power stations at some future time. It is no less reasonable to suppose that the gas engine will have a wide and increasing field of its own aside from these peculiarly favorable conditions. Both steam and gas have other competitors, which, however superior from the x^a point of view, are so limited as to location and size as to be only locally formidable.

I see no reason to believe that steam will be superseded to any great extent by any of the prime movers above mentioned. In fact, there will always remain certain locations and conditions which will absolutely debar gas or hydraulic sources from consideration. The problem before the steam engineer in the next century is that of getting away from the Carnot cycle and its limitations. We have the steam turbine or reaction motor, with an economy, in its infancy, of 16.4 pounds of steam per indicated horse power per hour. Better things than this will come.

Far better results than this will be demanded before the close of another century of progress. Civilization will not be content with a force obtained through five transformations from the natural material, when even at this time such force is obtained through one or two such transformations in the laboratory. By the close of the years beginning with the figures 19—, the question of exhaustion of the world's coal supply will be more than once considered. The power of the future will be obtained by methods of decomposition and synthesis, simple beyond conception in comparison with those known at present. Such a culmination will reduce to a common plane all of the five-transformation powers of to-day; but the outlook for the steam engine from our present standpoint is toward a perfection of mechanism, a standardization of types for recognized lines of work, leaving to gas, water, and the other forces the development of enterprises unusual in nature or in magnitude.

* *Journal of Electricity*, March, 1900, p. 47.

HEAVY MOTOR VEHICLES FOR ROAD SERVICE.

By Fred M. Maynard.

UNTIL within recent years, horse haulage, rivers, canals, and railways have been the only available systems of carriage between our various cities, towns and hamlets, each system having its own particular field of employment.

Horse haulage, which from time immemorial has provided a most satisfactory means for independent travel, is now found, for many purposes, to fall far short of present-day requirements. Its high cost and slow rate of progression when employed for heavy loads militate against its use from a commercial point of view, while hygienic considerations distinctly condemn its employment in crowded cities and towns on account of its unsanitary features.

Rivers and canals, although affording the cheapest system of carriage between fixed points, have three great drawbacks, namely: The length of time goods are in transit; the unloading from a vehicle into a barge or boat and vice versa at the end of the water journey; and lastly, availability only at places situated on such water ways.

Railways must always prove the cheapest medium for rapid transport over long distances, but below 40 miles the terminal charges are so great in proportion to the cost of haulage that promising scope is afforded to any system of road carriage that can by one straightforward journey dispense with such terminal charges.

Thus has it been gradually recognised that an enormous field exists for an intermediate form of transport, which, while independent of fixed routes, should possess greater latitude, and shew in use economy superior to that of the horse.

The traction engine partially fulfills these conditions, but the one great objection to its employment is that its full economy can be secured only when, comparatively speaking, very heavy loads are dealt with. This objection, however, does not hold good with the auto-waggon, which provides just that rapid and cheap form of independent direct transport for which so great a need exists at the present day.

The motor vehicle has practically established itself as the latest mechanical development of the century. In its lighter forms, it has become so common in the larger cities as no longer to attract attention. For heavier service—in which it seems destined to play even a larger part—progress is to be made solely by proof of greater economy and convenience. Mr. Maynard's actual comparisons of installation and working costs are therefore of great value. A second paper, in the next issue of this Magazine, will discuss and illustrate the specific forms which have become prominent in Great Britain. THE EDITORS.

Apart from the pecuniary saving, the benefits following in the train of the general adoption of motor traction cannot be over-estimated. The incalculable boon of cleaner streets, in point of view of the public health, should rank almost before economy, for it has long been a well-recognised fact among medical men that many epidemics, and also that fatal disease, tetanus, are in a very large measure due to the air of our streets forming a medium of suspension for germs which originally find a breeding bed in the predominating portion of the dirt caused by horse traffic in dry weather.

But with cleaner streets the cost of scavenging will be enormously reduced, and, owing to the absence of that pulverising action of the horses' hoofs, a corresponding saving in the expenditure for maintenance and repairs of the road surfaces will be the natural result.

Further, by the banishment of horses from the roadways of our cities, those terrible stone setts and cobbles, now compulsory on those routes traversed by heavy freight-carrying vehicles, would be no longer needed, but the extended use of asphalt or other silent road covering would be rendered not only possible, but necessary to obviate the excessive jarring of the motor vehicles and their machinery, thereby increasing their life, which could be still further augmented by the general employment of rubber and pneumatic tyres; such abrading and puncturing agents as flints and the like being conspicuous by their absence. An asphalt road requires only a water hose to keep it scrupulously clean. Another indirect benefit would be that with such silent rubber-tyred vehicles the continual clatter of street traffic, so harassing to the nerves of the city man, would be abolished.

As it is in its essentially commercial aspect only that the subject of motor haulage will be regarded by business men, on no better lines can the question, "Which is the cheaper form of transport?" be answered than by applying Lord Kelvin's rigorously accurate "Law of Economy" for its solution. This law tells us that "the most economical working is effected when the interest on the increment of capital is equal to the saving in annual expenses effected by such increment."

To reduce this to practice, it is necessary carefully to consider the cost of the various forms of carriage.

According to effects, the standard of work a horse is capable of performing is 14 nett ton miles in a day on ordinary roads, while two horses harnessed to one waggon may achieve 35 nett ton miles daily in regular work; or, to put it in other words, two horses will draw a nett load of 3 tons at an average speed of 2 miles per hour for 6 hours $= 3 \times 2 \times 6 =$ nett ton miles.

The prime cost of a two-horse waggon will probably be:

	£	s.	d.
One 3-ton lurry	60	00	00
Two horses at £50.0.0	100	00	00
Two sets harness, etc., at £7.10.0	15	00	00
	175	00	00

Working expenses per annum:

	£	s.	d.
Interest, 5 per cent	8	15	00
Depreciation, 15 per cent	26	5	00
Fodder and bedding at 12s. per week	62	8	00
Insurance, 2 per cent	1	15	00
Repairs to dray, harness, etc	8	00	00
Shoeing at 1s. 6d. per week each	7	16	00
Horsekeeper (share)	13	00	00
Veterinary surgeon	2	2	00
Rent, rates and taxes	13	00	00
Driver	65	00	00
	208	1	00

The prime cost of a commercially reliable steam dray carrying a maximum load of 3 tons is £652.10.0.

The annual working costs of such a dray will be as follows:

	£	s.	d.
Interest, 5 per cent	32	12	6
Depreciation, 15 per cent	97	17	6
Insurance	10	18	00
Repairs (approximately)	30	00	00
Rent, rates and taxes	5	5	00
Fuel, 8.88 pounds anthracite coal per vehicle mile, × 12 × 260 = 12 tons, 8 cwt. at 20s	12	8	00
Coal for raising steam	6	10	00
Wood for lighting fire		15	00
Water, 7.15 gallons per vehicle mile, × 12 × 260 = 22,308 gallons at 1s. per 1,000	1	2	4
Driver's wages at 35s. per week	91	00	00
Lubricating oil and waste	3	10	00
	291	18	4

In this case the interest on the increment of capital is (£652.10.0 — £175 = £477.10.0 at 5 per cent. =) £231.8.0, but the annual working expenses of the steam dray exceed this by £59.19.4 (£83.17.4 — £23.18.0 = £59.19.4); so that evidently it will not pay to substitute an auto-waggon for a horse-drawn one where so little hauling is required.

The daily work of a steam dray is at least 3 tons carried at the rate of 5 miles an hour for, say, ten hours, or 3 × 5 × 10 = 150 nett ton miles, giving in the year of 260 working days 150 × 260 = 39,000 nett ton miles. Now, as by the previous example it is seen that one two-horse dray can deal with only 36 nett ton miles per day, it will be evident that 150 nett ton miles will require 150 ÷ 36 = 4.3 two-horse units, or, say, 9 horses and 4 waggons, the cost working out as follows:

	£	s.	d.
Four 3-ton waggons, at £60	240	00	00
Nine strong horses, at £70	630	00	00
Nine sets harness, rigs, etc., at £7.10.0	67	10	00
	937	10	00

Annual working expenses:

	£	s.	d.
Interest, at 5 per cent. on £937.10.0	46	17	6
Depreciation, 15 per cent	140	12	6
Fodder and bedding, at 12s. week each	280	16	00
Shoeing at 1s. 6d. per week each	35	2	00
Repairs to waggons, harness, etc	36	00	00
Insurance, at 2 per cent	18	15	00
Horsekeeper (ostler) at 25s	65	00	00
Veterinary surgeon	9	9	00
Rent, rates and taxes	78	00	00
Four drivers, at 25s. per week	260	00	00
	970	12	00

The fixed annual charges for the motor waggon will be the same as in the previous example, but the running cost will be somewhat larger, and is as follows:

Fixed charges:	£	s.	d.
Interest, 5 per cent	32	12	6
Depreciation, 15 per cent	97	17	6
Running costs:			
Insurance, 2 per cent	13	1	00
Repairs (estimated)	100	00	00
Rent, rates and taxes	5	5	00
Fuel, 8.88 lbs. anthracite coal per vehicle mile, × 50 × 260 = 51.54 tons at 20s	51	10	10
Coal for raising steam	6	10	00
Wood for lighting fire		15	00
Water, 7.15 gallons per vehicle mile, × 50 × 260 = 92,950 gallons at 1s. per 1,000	4	13	00
Lubricating oil and waste	12	00	00
Wages driver, at 35s. per week	91	00	00
	415	4	10

Comparison of costs:

	£	s.	d.
Horse drays	970	12	00
Steam drays	415	4	10
Annual saving	555	7	2

In this case, in place of an increment of capital being necessary, a substantial reduction in prime cost is effected and a maximum economy is secured. From the two examples it will be easy for anyone interested to work out for himself whether the adoption of a motor dray will prove a pecuniary benefit to him or not, and to what extent.

SAVING ON RAILWAY RATES (from actual figures).—The railway rate between two towns 11 miles apart for a certain class of goods is 4s. 6d. per ton, and the total weekly load to be moved in both direc-

tions was 100 tons, the annual cost for which was 100 × 4s. 6d. × 52 = £1,170.0.0. It was found, however, that by employing a steam dray and trailing vehicle, two loads of 5 tons in each direction, or a total of 20 tons, could be carried in a day five days in the week, at a cost of £646.2.4, shewing a saving as follows:

	£	s.	d.
Railway charge	1,170	00	00
Steam road haulage	646	2	4
Annual saving	523	19	8

At the same time the goods were delivered at their destination much more quickly, and all handling at the depots at either end of railway journey was dispensed with.

Saving on Canal Rates.—The mill of a large Manchester cotton firm is situated in a town 18 miles from that city, and their traffic, which had been carried by canal between the two places, amounted to 50 tons per week, the freight on which was 6s. 8d. per ton, giving a yearly cost of £866.13.4 for canal carriage (which necessitated horse delivery in Manchester). By the adoption of a steam waggon and trailer, a full load of 5 tons being carried into Manchester twice a day, the whole of their traffic was dealt with in five days a week; the cost being as follows:

	£	s.	d.
Prime cost of steam waggon and trailer	697	10	00
Working costs of same per annum:	£	s.	d.
Interest, 5 per cent	34	17	6
Depreciation, 15 per cent	104	12	6
Insurance, 2 per cent	13	19	00
Rent, rates and taxes	7	7	00
Repairs (estimated)	125	00	00
Fuel, 9.37 lbs. coal per vehicle mile, *loaded*, = 36 × 9.37 × 260 = 39 tons 3 hundredweight at 20s. per ton =	39	3	00
Fuel, 7.02 lbs. coal per vehicle mile, *light*, = 36 × 7.02 × 260 = 29 tons 7 hundredweight at 20s. per ton =	29	7	00
Coal for raising steam	8	2	6
Wood for lighting fire		15	00
Water, 7.37 gallons per vehicle mile, *loaded*, = 36 × 7.37 × 260 = 68,983 gallons at 1s. per 1,000 =	3	9	00
Water, 5.52 gallons per vehicle mile, *light*, = 36 × 5.52 × 260 = 19,872 gallons at 1s. per 1,000 =	1	00	00
Oil and waste (stores)	13	10	00
Drivers, two, at 35s. per week each	182	00	00
Brakesman for trailer, at 20s	52	00	00
Total	615	2	6

Comparison of costs:

By canal	866	13	4
Auto-waggon	615	2	6
Annual saving	251	10	10

This is an example in which a *full* load could be secured only *one* way, yet even with this a saving was secured of no less than 28¾ per cent. upon what has always been looked upon as the very cheapest form of transport; the goods being delivered in a much shorter space of time, and transshipment from barge to lurry in Manchester being entirely obviated. Naturally, had it been possible to arrange for a return load, the gain would have been greater by the value of that extra carriage, less running expenses, fuel, water and stores.

The foregoing examples clearly demonstrate that the auto-waggon is within certain limits undoubtedly the most economical of all systems of land carriage.

Among the various sources of energy suggested for the propulsion of these heavy automobiles we have electricity, compressed air, petroleum, and steam.

Electric motors are clean, extremely convenient and simple, free from all vibration and danger, and altogether an ideal type of motor; but for freight-carrying waggons to run 40 miles without recharging, electricity appears at the present time impracticable; the great dead weight of the accumulators necessary to store the requisite energy being apparently an insuperable difficulty, especially where a fairly heavy useful load is required to be carried. Their high cost and short life also greatly militate against their use for heavy-vehicle propulsion, as in this service disintegration naturally takes place much more rapidly than in a stationary battery, owing to the vibration over rough roads.

Compressed air would, at first sight, seem to fulfill all requirements, owing to an entire absence of the waste products of combustion and the absolutely innocuous exhaust from the motor. Both in America and France much time and money are being expended in experimenting, with a view to perfecting this ideal source of energy. Naturally, the factors which govern its suitability for the purpose are, first, its safety, this being based upon the means adopted for its storage, and second, its economy, which is dependent partly upon the total useful load it is possible to carry on a vehicle of a given tare weight, inclusive of the charged air cylinders. For universal use, however, there would appear to be certain objections to this system; in the first place, an air-compressing plant would be essential, and it would certainly not pay a user to erect such a plant for the exclusive supply of one or two vehicles, while, when a central supply has to be relied upon, the "independence" of the motor vehicle is at once sacrificed.

Oil (or more correctly, petrol) motor waggons of the German

Daimler type have shown themselves both reliable and economical in running, but dependent as they are on the employment of a light mineral spirit, which is not universally obtainable, and being somewhat delicate and complicated in construction, they are not exactly suited for regular heavy work; another great objection to their use being that variation of speed is almost entirely dependent upon gearing, there being no elasticity in the oil motor as in the steam engine.

This, therefore, brings us to the consideration of steam, which is generally admitted to be the only suitable means of propulsion at the present day for heavy motor vehicles, combining as it does the great essentials of independent running (fuel and water being obtainable where no other sources of energy are to be found), great reliability, simplicity, economy, and flexibility.

The boiler for use on an automobile must needs be small, light, of great strength, and capable of quickly making steam at the right pressure and in sufficient quantity. Further, it is necessary that it should be constructed of material and to a design that will pass the recognised boiler authorities. Unfortunately, many of the steam generators at present in use are built without any such official inspection or testing; they are very light in construction, offer a small factor of safety, and have but little endurance.

The three types of generators at present employed on various vehicles are the water-tube, fire-tube, and flashing or "waterless" boiler. Among the first named may be mentioned the Thorneycroft, as designed by this celebrated firm for use on their torpedo boats, the Merryweather, originally employed on steam fire engines, and the French de Dion et Bouton, which, however, is very heavy and not easily accessible; as a class the water-tube is distinctly the most efficient and the safest, although somewhat more costly than either of the other types.

The only English fire-tube automobile boiler of any note is the Leyland; this is a vertical generator, simple in construction, with tubes of less diameter at the top than at the bottom. It gives fairly satisfactory results in use.

Modifications of the original Serpollet flash boiler have been adopted in the steam drays of Simpson and Bodman, of Manchester, and Musker, of Liverpool. The advocates of this type of generator put forward very specious arguments in its favour, but so far, with the exception of the Serpollet, they are yet in their experimental stage only, none having passed through the searching test of actual lengthened road service; among well-informed engineers, however, the

apparent advantages of the system are heavily discounted, its inherent weaknesses being so many.

Although in one or two cases condensers are employed, the opinion of those competent to judge is that the great attendant disadvantages of increased cost, weight, and complication more than outweigh their nominal advantages, and that where water is obtainable at points not more than 15 miles apart a condenser is practically of very little value.

The steam motors employed are small and run at a high speed of revolution; both horizontal and vertical types are in use, and are generally of the two-stage, or triple-expansion pattern; in some instances the engines are only uni-direction. The necessity of high steam pressures to obtain a large power from these small motors will be at once apparent. Owing to the high speeds employed, ample bearing surfaces and automatic lubrication are two indispensable provisions.

The relative horse power for given loads is anything but uniform, and clearly shows why the cost prices of the vehicles under notice vary within such wide limits. While one firm gives an engine with an available horse power of 35 for a load of 3 tons, another will allow only 14 brake horse power for a load of nearly 4½ tons.

TRANSMISSION.—From the engine to the road wheels the power is usually transmitted by means of spur or bevel gearing to an intermediate or counter-shaft, and thence through differential gear and sprockets and chains to the driving wheels. In those cases where chains are dispensed with, plain spur or helical gearing is employed for the final drive. This involves a somewhat greater outlay, but it is more certain in action and is almost everlasting in wear. The renewal of worn-out driving chains, owing to their short life, forms a heavy item in the repair account of chain-driven heavy freight vehicles.

WEIGHT, DISTRIBUTION AND ADHESION.—The importance of placing as much as possible of the weight of the vehicle upon the driving axle is scarcely to be over-estimated, as otherwise the full propulsive effort of the engine cannot be effectively applied when the waggon is running light. This was very pointedly illustrated at the Liverpool hill-climbing trials last year, when the performances of some of the competing vehicles were curiously erratic, owing to the lack of appreciation on the part of the builders of this most important detail in their construction.

My second article will take up the specific forms of motor waggon which have proved successful in Great Britain.

EDITORIAL COMMENT

The fog which hides events in China is still so dense that, as we go to press, it is not yet possible to do more than guess vaguely at the actual state of affairs in Pekin. Hope has given way to fear that the horrifying reports of early July are only too well founded, based, it is to be feared, on facts which seem to grow even more hideous as they are more clearly seen.

But one thing is very certain: No matter what the immediate incident, the regeneration of China is under way, and the present months of struggle and agony are accomplishing what would otherwise have taken decades. As Mr. Foord puts it elsewhere in this issue, the new China is being born—*is* born already. There is a long period of anxiety still to be passed; the weakness of the child and the possible wrangles among its jealous protectors threaten protracted dangers; but so far the latter difficulty has been much less apparent than was to be feared—or even to be expected. If, as heretofore suggested in these pages, England, the United States, Germany, and Japan, are moved by an identity of aim and a unity of purpose in standing for the integrity of the empire and the open door, there is little fear of any extreme resistance.

* * *

In one most important point the situation is clear, as it has never been before. This is in the official definition of the policy of the United States. The frank, positive, and definite declaration by the Secretary of State, sent in a circular telegram of instruction to the United States Ambassadors and Ministers throughout Europe and Asia, has not yet attracted the notice its importance demands. It is probably the most significant document issued by the present administration:

"In this critical posture of affairs in China it is deemed appropriate to define the attitude of the United States as far as present circumstances permit this to be done. We adhere to the policy initiated by us in 1857 of peace with the Chinese nation, of furtherance of lawful commerce, and of protection of lives and property of our citizens by all means guaranteed under extra-territorial treaty rights and by the law of nations. If wrong be done to our citizens, we propose to hold the responsible authorities to the uttermost accountability.

"We regard the condition at Pekin as one of virtual anarchy, whereby power and responsibility is practically devolved upon the local provincial authorities. So long as they are not in overt collusion with rebellion and use their power to protect foreign life and property, we regard them as representing the Chinese people, with whom we seek to remain in peace and friendship.

"The purpose of the President is, as it has been heretofore, to act concurrently with the other Powers, first, in opening up communication with Pekin and rescuing the American officials, missionaries, and other Americans who are in danger; secondly, in affording all possible protection everywhere in China to American life and property; thirdly, in guarding and protecting all legitimate American interests; and fourthly, in aiding to prevent a spread of the disorders to the other provinces of the empire and a recurrence of such disasters.

"It is, of course, too early to forecast the means of attaining this last result, but the policy of the Government of the United States is to seek a solution which may bring about permanent safety and peace in China, preserve Chinese territorial and administrative entity, protect all rights guaranteed to friendly Powers by

treaty and in law, and safeguard for the world the principle of equal and impartial trade with all parts of the Chinese Empire."

The concluding lines are most significant. The United States has openly announced its adherence to the course uniformly urged by the broadest and best informed students of the question—the course advocated in these pages by Minister Denby and Prof. E. P. Allen, by Mr. J. S. Fearon and Hon. John Barrett, by Gen. Wm. Barclay Parsons and Mr. John Foord. With England's vast power directed to the same end, and with Germany and Japan, as may be supposed, acting in unison, opposition need hardly be expected, and, if offered, is foredoomed to failure.

* * *

The awful fire at the piers of the North German Lloyd Line, at Hoboken, has brought out very general criticism and suggestion on certain points of construction and docking practice, but as yet little on the use of wood in ship-building, so far as the spread of fire is concerned. In view of the interest in the Belleisle experiments, it is to be supposed that later a thorough study of the wrecked hulls will be made, and its results are not likely to encourage those who are optimistic regarding the possibility of controlling a fire once well started on shipboard, when wood is present in any large quantity in the form of partitions, sheathing, trim, or furniture. The ships destroyed were all modern craft, built of steel quite as far as is customary in the merchant marine; but the fire seems to have seized them with such frightful rapidity that there was no chance whatever for anyone who was below to reach the decks. And when the fire had once gained headway, the most powerful streams which could be thrown seemed almost without effect.

With great unanimity, however, the press has criticised the danger of tying up these huge vessels, probably close to non-fireproof piers or warehouses filled with most inflammable goods, and leaving them without motive power of their own, or any pre-arranged and sufficient assistance in the way of tugs to move them to safety. They are practically at the mercy of any careless smoker or carrier of fire on the piers, or of any burning barge or lighter which may drift against them.

The second matter which calls out general condemnation is the smallness of the ports. Many of the wretched victims were overcome while standing at open portholes, through which they could call and stretch their arms, but by no possibility could escape. Admiral Melville, U. S. N., who was present at the fire seeking to give help, says: "The most cruel part of it all seemed to be that, had the portholes been a few inches wider, every person would have escaped. It is a common practice in the engineering profession to make what are known as manholes and manhole plates, eleven by thirteen inches, in the shape of ovals, through which an ordinary man of 200 pounds can readily pass. The ports of this fatal ship, which are only eight to ten inches in diameter, are an abomination." Another commentator suggests that if the expense of making all portholes large be considered prohibitory, at least one of sufficient size to permit escape should be provided in each compartment. Neither of these is a lay opinion. It will be interesting to hear from the marine architects and constructors.

* * *

The month which was marked by such disaster to the North German Lloyd has witnessed the maiden voyage of the newest and greatest ship of the other great German steamship company. The Deutschland, of the Hamburg-American Line, finished her maiden voyage to New York on July 12, making the run of 3,044 nautical miles from Plymouth in 5 days, 16 hours, 15 minutes, an average speed of 22.42 knots. This may be compared with the maiden voyage of the Kaiser Wilhelm der Grosse, 3,050 nautical miles in 5 days, 22 hours, 35 minutes, an average speed of 21.39 knots. The Deutschland, second in size of the Atlantic express steamers, with 5,000 tons less displacement and 5,000 more horse-power than the Oceanic, promises to lead the merchant fleets in speed.

REVIEW OF THE BRITISH PRESS

Practical Notes on Electric Traction.

In a paper recently presented before the Society of Engineers, Mr. Algernon Hamo Binyon discussed a number of very practical points connected with electric traction. Although most of these were based upon American practice, they represent the lines along which the probable development of traction in Great Britain may be expected, and hence an abstract of the paper will be appropriate here.

In order to illustrate the extent of the tide of human traffic, a comparison is made between the cities of London and New York. In London the underground railways take only 19 per cent. of the total traffic, while 81 per cent. is conveyed by the omnibuses and tramways. The whole population of London, about 5½ millions, travels 124 times over in the course of a year, while in New York, the population of 3½ millions travels 210 times over in a year; 70 per cent. of the New York traffic being over electric tramways and 30 per cent. on the elevated railways.

It is evident from the above that the underground railways are not taking a sufficient share of the traffic, but this is doubtless due to the discomforts caused by smoke and gas. When the underground roads are operated electrically the traffic will doubtless be greatly increased.

Mr. Binyon says that England cannot expect to destroy the lead which America has secured in the production of electric traction material, but he hopes that British manufacturers will take the matter up seriously and secure at least a fair share of this important work. At the present time the United Kingdom has only about 1,000 miles of electric tramway, while America has 14,000 miles, the number of passengers carried yearly being 3,000 millions in America and 480 millions in Great Britain.

A strong argument is made in the paper in favour of the overhead trolley system, as being the most efficient, least expensive in first cost and up keep and altogether safe and reliable. Much of the unsightliness can be avoided by the use of the side trolley, which dispenses with long brackets.

When the London United and the London County Council Tramways are finished there will be a complete net of quick travelling lines from the suburbs to London. The competition of these electric tramways will doubtless be strongly felt in the future by the railway companies, who will in time be forced to adopt electric traction to cope with suburban traffic within a radius of from 10 to 25 miles round London, this being probably the range within which competition will exist, and beyond which the steam locomotive will beat its rival.

In discussing the question of distribution, Mr. Binyon shows the advantages due to the use of sub-stations, offsetting these with the objections showing that no general rules can be laid down in this matter, as each particular case has to be worked out on its own merits. In some instances the subject of a combined traction and lighting plant has been advocated, but the investigation of this question by Mr. Parshall, Lord Kelvin and Dr. John Hopkinson has shown that this is not generally advisable. The maximum loads in lighting and traction often occur at the same time, so that the total capacity of the station would have to be designed for this combined possible maximum. It is a well demonstrated fact that electricity can be generated at a much lower cost for traction than for electric lighting, so that it seems inadvisable to burden a traction station with lighting service unless the whole plant is a small one.

Concerning the much discussed subject of motive power, Mr. Binyon adheres to the plan of large, slow-moving engines with heavy fly-wheels.

"An engine to operate in electric railway practice must mechanically be of most substantial nature, as there are far greater fluctuations in load in this work than in

any other kind, which necessitate special designs fully to meet all requirements. It must not only regulate under these severe conditions, but be proportioned in its entire construction to stand heavy overloads."

"With a heavy fly-wheel and sensitive governor, an engine can cope economically with this special work, if designed to operate economically at about the average load, the fly-wheel having such a weight that its live energy is able to give out the extra amount of work called for by sudden maximum demands.

In view of the scarcity of data about modern electric traction plants, it is not easy to compute the cost of power, but from the estimates of Mr. Philip Dawson and of Dr. Emery for an engine of 500 horse power, the cost of a horse power year, working 24 hours daily, ranges from £8 to £10, while with a plant of 20,000 horse power this may be reduced to about £6.

Mr. Binyon goes into detailed descriptions of trucks, motors, circuit-breakers and rail bonds, and gives data as to the power consumption of cars, showing the relation of the speed and the number of stops to the power required. He advocates the use of meters on the cars, experience in America having shown that 30 to 40 per cent. of power could be saved by the reduction of waste caused by careless handling of the controller.

The whole paper is an excellent presentation of modern practice in electric tramway construction, and as such will be found useful for reference.

American Corliss Engine Practice.

In view of the general interest taken in American power plant design, the articles of Mr. Charles Day upon American Corliss Engines, recently appearing in *The Engineer*, are worthy of comment.

When, with the advent of electric lighting, the single-valve, high-speed automatic engine came into very general use, many people thought that the older, long-stroke engine of moderate rotative speed would soon become a thing of the past. The higher economy of the Corliss engine, however, enabled it to hold its own ground, even though it was at first necessary to drive the dynamos by means of belts. Since the introduction of slower speed electric generators it has become entirely possible to use the Corliss engine connected directly to the dynamo, and for large stations this has become the accepted combination.

The type most generally adopted is the cross-compound, with cranks at right angles, the dynamo and fly-wheel being fixed close together between the cranks. Horizontal engines have been extensively used, but vertical engines are coming into general favour, especially for the larger sizes. An important point in favour of the cross-compound type is that the crank shaft has only two bearings, both of which work under similar conditions of load, hence there is little possibility of the shaft friction increasing materially in consequence of the bearings wearing out of line. By careful proportioning of cylinder diameters the steam economy of compound engines under power house conditions can be made practically equal to that of triple-expansion engines.

Much has been said about the large shaft diameters used in the engines recently designed for electric power stations, but Mr. Day considers these fully justified.

"Taking the consideration of the heavier crank shafts first, as attention has been prominently drawn to this in connection with the tenders for engines for the Glasgow Corporation, experience has taught English engineers what sizes of crank shafts are necessary for the ordinary conditions met with in driving textile and other mills, and what engines I have seen of American design for similar work certainly are not heavier, either in the crank shafts or other parts, than those made by good English firms. This being the case, it is evident that some special necessity must have been found for making crank shafts which have dynamos mounted directly on them much heavier, and with much larger bearings than are adopted for mill engines. Remembering that, in addition to the fly-wheel, the heavy armature of a dynamo is fixed on the crank shaft, it is evident that a stronger shaft and larger bearings are necessary than if only a fly-wheel were required to be carried, but in looking into the list of sizes given further on it will be seen that both the bearing and shaft sizes are greater than are necessary for the mere carrying of the additional weight.

"American designers say that the greatly-increased strength is necessary in consequence of the possibility of the downward forces due to gravity being greatly increased by unbalanced magnetic pull on the armature, as, if by wear, imperfect setting, or any other cause, the center of the armature is below the center of the magnet poles, the magnetic attraction acting downwards may be greatly in excess of that acting upwards. The strength of the shaft and the area of the bearings must, therefore, be such that this additional weight, as it may for simplicity be termed, can safely be carried.

"The amount of this magnetic pull may be very considerable, and a prominent electrical firm give it as 18 tons for a deviation in centers of 1-16 in. of a 600-kilowatt generator. Remembering that the dynamo frame is often carried independently of the engine frames, 1-16 in. deviation is certainly the very lowest that should be reckoned on, and twice this amount would not be unlikely to occur in practice. At one station this unbalanced magnetic pull between the armature and the dynamo frame on one occasion became so great that, combined with the torsion forces, it caused the breakage of all the bolts holding down the dynamo frame. The damage which was done when the pole pieces came into contact with the armature hardly needs description.

"From the foregoing I think it is clear that American engineers have valid reasons for their practice in regard to crank shafts, and until British engine builders have had sufficiently long experience of engines of the class under consideration, the safe policy is to follow the example set by our American *confrères*, so long as the dynamos to be fixed on the shafts are so designed as to render possible the serious unbalanced pull which I have described."

Mr. Day's paper contains drawings and descriptions of a number of details, showing those features which are peculiar to American practice. The willingness of American engineers to show visitors over their works is commented on most favourably, and the rapid strides which American competitors have made, is quoted as sufficient justification of the soundness of this open-minded policy.

The Belleisle Experiment.

THE plan of the British Admiralty to conduct a practical experiment as to the effect of gun-fire upon armour by devoting the Belleisle to destruction by the guns of the Majestic, has attracted much interested attention among engineers. Although it was at first announced that the whole matter was to be conducted with entire secrecy, this condition appears to have been carried out only as regards the first part of the programme, since the Belleisle, after the experiments, was towed to Portsmouth dockyard, where photographs were allowed to be taken, and a general examination permitted.

From a very fully illustrated account in *The Engineer* an abstract of the general results is here given, and possibly some useful deductions made:

The Belleisle was of about 5,000 tons displacement, and the iron armour disposed as follows:

Belt .....12 in.—6 in.
Battery .....10 in.—8 in.
Redoubt below battery..... 9 in.—8 in.
Conning tower.....12 in.

In construction she may be considered a cross between a central battery ship and a coast defender, originally for Turkey, and purchased by Great Britain in 1878. The Majestic, by which she was attacked, carried 12 in., 6 in., and 3 in. guns, all of which were fired, the 12 in. guns using both common shell and armour piercing shot, while the 6 in. guns fired common shot and lyddite. The attacking vessel proceeded at a speed of 6 knots, the range being 1,300 to 1,700 yards, the duration of fire lasting about 9 minutes.

About 30 to 40 per cent. of the projectiles fired were effective, and a number of the hits were very destructive in their effects. The general result, as might have been expected, was the prompt sinking of the helpless target, but as she had been intentionally moored over a convenient shoal, there was little difficulty in raising her and studying the manner in which she had been affected by the ordeal.

As summed up by *The Engineer*, the immediate conclusions drawn from the experiment were as follows:

Save in absolutely still water, a complete water-line belt has no value whatever.

It is easier to hit a ship end-on than when she presents her broadside.

The battle of the future will be won by whoever gets in the first hit, or first one minute's hitting.

The theorists have been shown to be correct in nearly all their theories.

Danger of fire from woodwork is quite a minor affair, and if the main hoses are protected and the ship well doused beforehand, no serious danger is to be apprehended from fire.

The 12 in. gun is the gun of the future.

To these observations may be added some later ones as to the destructive effects of lyddite. The powerful upward effect of the explosions seems to have been especially marked, the burst-up condition of the decks of the Belleisle showing conclusively the behaviour of the lyddite shells.

The extent to which definite conclusions of value can be drawn from a single experiment of this kind appears, however, to be very limited. It is not easy to reproduce the conditions of actual warfare in any experimental attack. The return fire of the attacked ship would surely do something to affect the accuracy of the attacking fire, and ranges of 1,700 yards would not be reached until after heavier firing at longer distances had occurred. In many cases also the speed of the vessels would be greater than in this experiment. The battle at Santiago was fought at full speed under forced draught, and only toward the close did the range become short, while the Belleisle remained stationary and silent, differing from a land target only in construction, and in the opportunity for ascertaining the probable effects of fire upon the particular class of structure to which the doomed vessel belonged.

To draw any very positive conclusions from such a single experiment seems very doubtful, and it is a question whether the information attained has been worth its cost. The moral effect of the display may have accomplished all that was intended, especially upon nations possessing in their navies a number of vessels not greatly differing in type from the Belleisle.

To the engineer, however, such an experiment hardly appeals as a source of information, and it is not very probable that the builders of guns or the makers of armour plate will make any extensive changes in their methods as a result of the 9 minutes' work of the Majestic upon the Belleisle.

Examinations for Patents.

THERE is probably no one subject connected with engineering law about which so many differences of opinion exist as that of patents. In some countries the patent is granted to the first applicant; in others the applicant must make claim to be the original inventor. Again, in some instances, the application is granted without regard to the fact of possible anticipation; while in others, the whole state of the art to which the application relates is made the subject of an exhaustive search, and the application is rejected if any previous patent appears to cover the subject, or even if it appears to have been included in any previously published account, although not the subject of a patent.

In view of the fact that a Departmental Committee of the Board of Trade has under consideration the question of possible modifications of Patent Office practice in Great Britain, the subject of the advisability of introducing the examination system into the British Patent Office is discussed in recent issues of *Engineering*, from which we make some abstracts.

The questions under consideration by the committee refer respectively to the subjects of examination as to novelty, compulsory licenses and the granting of patents to foreign inventions. Of these the first is considered at length, and some interesting points, especially in comparison with American practice, are brought out.

As the question is literally put, it relates to the conduct of the office, "in respect of inventions which are obviously old, or which the information recorded in the office shows to have been previously protected by letters patent in this country" (England).

Naturally the determination of the novelty or otherwise of an invention involves the introduction of a system of examination similar to that in operation in the United States, and it remains to be seen how desirable this practice really is. Theoretically, it appears to be all right; practically, it does not always work well. There are two parties to be considered in the case,

as is indeed usually the case; one being the inventor, the other the public. If the applicant for a patent is to be saved the expense of a search, and protected, so to speak, from the loss inventors now frequently incur through spending time and money over an invention which turns out to have been anticipated, the public also has a right to be equally informed, and, in case of necessity for defence, be put in possession of the facts already communicated at the public expense to the patentee.

Both in the United States and in Germany, examinations as to novelty are conducted, and provision is made for repeated appeals in case the applicant is dissatisfied with the apparent anticipations made by the examiners.

"The American and German systems are both open to serious objection. The decision in every case naturally depends upon the temperament and the peculiar ideas of the examiner. One examiner, or board of examiners, will recognise the existence of novelty and patentable invention where another examiner, or board of examiners, will be clearly of opinion that there is nothing of the kind. And the fate of an application is mostly determined upon mere documents, and, necessarily, in the absence of such evidence respecting matters of fact, as is usually produced to a Court of Law in the United Kingdom, when it is called upon to pronounce as to the validity or invalidity of letters patent."

It is well recognised in the United States that the most complete examination which the Patent Office is able to make gives no assurance to the patentee that there are no anticipating inventions in existence. The examinations are regarded as a convenient guide to the applicant in framing and amending his specification, but if the invention turns out to be one of much commercial value, it is almost certain to be made the object of infringement, and an appeal to the courts becomes necessary. So generally understood is this fact that it has been said that no American patent is of any real force until its validity has been tested in the courts, the labourious and painstaking searches of the Patent Office being considered of little or no real value.

As a matter of fact, there appears to be no real reason why the recording of the title to an invention should be greatly different from that of any other piece of property. No attempt is made to inquire into the validity of the title to a piece of real estate at the office where it is recorded, that being left altogether to the interested parties, and if questioned is decided by the courts. Years of experience in America have shown that the examination system does not in any way replace appeal to the courts, and the small esteem in which it is held in the United States should be fully appreciated in Great Britain before the proposed change is made.

Electric Traction on the London Metropolitan.

EVERYONE who has traveled upon the Metropolitan District Railway has doubtless rejoiced to hear that a beginning has at last been made towards the replacement of steam traction with electric driving. The preliminary experiments have been made upon a short piece of line only 4,000 feet in length, between Earl's Court and High street, Kensington, and from an account in *The Electrical Engineer* we abstract some details of this installation.

Two lines of conductors are used, one on each side of the track, for the lead and return currents, the conductors being of inverted steel channels of section corresponding to one square inch in conductivity. The current passes from the conductors to the motors by means of sleepers, and as there are a number of gaps necessary in the conductors, a slipper is placed on each carriage, so that one end of the train makes a contact before the other runs off. The number of contacts also prevents undue sparking.

The train is provided with a motor coach at each end, each coach having four motors, of the Siemens railway type. The controller is so arranged that the motors all start first in series and end up by all being in parallel at maximum speed, and as each motor has a maximum capacity of 200 horse power, each coach has a total of 800 horse power.

The power plant is equipped with Babcock and Wilcox boilers and Belliss engines, there being two generating sets, with two-pole dynamos, compounded to give 500 volts at no load and 550 volts at

the full load of 385 amperes. Curves showing the results of tests are given. "On a two-hour continuous run without undue heating, the motor, with a current of 250 amperes, gave a pull of 2,300 pounds, at a speed equal to 25 miles an hour. A further test on the line itself showed that the electric locomotive was much more powerful than the ordinary steam locomotive on the line. This was shown by the fact that a steam locomotive was unable to pull up the grades the electric train loaded to 220 tons. After this had been proved, steam was shut off, and the electric locomotive started the train with the steam locomotive coupled to it and took the whole up the grade easily. As regards the acceleration obtained this proves to be nearly 1.25 feet per second. Owing to the small amount of generating plant, however, this acceleration cannot be maintained after the motors are in parallel, as the current available is too little.

"Maximum speeds of 38 to 39 miles per hour have been reached, and great improvements on the scheduled times with steam locomotives are obtained. Quicker travelling and more accommodation is thus ensured by the electric train, in spite of the fact that the experimental equipment is loaded by the weight of an idle locomotive. These inducements are great, and should be quite sufficient to ensure the complete conversion of the Inner Circle."

While the above advantages are undoubtedly worthy of consideration, they are altogether subordinate to the one great object of the avoidance of smoke and gases. There is little doubt that the Metropolitan would be far more extensively patronised were it not made so offensive by the suffocating atmosphere, and with these objections removed, a large increase in the number of passengers would follow.

An underground road appears to be especially well adapted for electric traction, the complete control which is possible over the entire way rendering it possible to use devices and methods which would be out of the question upon the streets of a city. It is to be hoped that this experimental section of electrical traction will prove to be a forerunner of the early and complete abolition of steam traction upon the whole of the Metropolitan system.

The 1000-Mile Automobile Trial.

THERE is abundant evidence on every hand that the automobile is emerging from its original position as a pleasure vehicle into the much more important one of a commercial and business proposition. Much of the progress in this direction has originated in England, where the pleasure vehicle has until now made far less progress than in France. The heavy motor trials at Liverpool added much to our knowledge as regards that class of traffic, and the trial of 1,000 miles run, recently completed under the auspices of the Automobile Club, has been a useful contribution to the solution of the problem of endurance.

A general review of the trial, as given in *The Engineer*, enables some conclusions to be drawn from the trials which may be of advantage in designing future vehicles, and an abstract will be of interest. The tyres were naturally the principal feature which the trial really concerned. All the tyres were of rubber, and most of them were pneumatic. In most cases repairs of tyres were necessary, and almost every vehicle experienced trouble in this respect. The solid rubber tyres fared better than the pneumatic, but some satisfactory substitute for either form appears to be most desirable.

It is unfortunate that but two steam carriages were represented at the trials, since neither of them came out well, and hence steam as a motive power was not seen to advantage, while had a greater proportion of steam-driven vehicles competed, the result might have been different. Apart from trouble with the tyres the principal difficulty appeared to be the action of the wind on the oil lamps under the boilers, while priming was also a difficulty. Clearly the boiler is the vital part of a steam automobile.

So far as the definite result of the trials is concerned, there appears to be no doubt as to the success of the internal combustion motors. Certain defects, such as the blowing out of the flames of the ignition tubes, and the noisy action of the gearing, made themselves apparent, but with these exceptions the vehicles of this class undoubtedly showed their superiority.

Among the immediate lessons to be learned by the trials, several points of prac-

tical value may be mentioned. For use on common roads, with all the irregularities which must necessarily be encountered, lightness must be sacrificed, and strength given the most consideration. As the weakest link in a chain is the measure of its strength, so the roughest place in a road is the measure of its condition. Bearing this in mind, it is evident that by strengthening the framing, making the wheels a little heavier, fitting more durable tyres, and, above all, providing a fair margin of excess power, many vehicles which were right in principle would have shown better results in practice. The desire for lightness is responsible for the development of many apparent defects which would not have appeared had but little more care been given to strength and power.

Taken for all in all, the trial was very satisfactory. The general result, regardless of the performance of individuals, showed that the motor vehicle is a thoroughly feasible machine for long-distance road traffic, even over roads of a difficult character. Electricity as a motive power has been relegated to its proper place, as suitable for short distance work, especially in cities, but for general road traffic the competition lies between the steam engine and the internal combustion motor. For heavy trucks it appears that steam power, properly applied, has many advantages, while for lighter vehicles the internal combustion motor is both convenient and satisfactory.

Such trials as that recently held must go far to popularise the motor vehicle and to dispel much of the prejudice existing against it in certain quarters. The noise, even of the noisiest petroleum motor, is not so great as that made by a pair of tramping 'bus horses, nor is the odour of escaping vapour as objectionable as that caused by the filth due to the horse. A few more such public exhibitions of the real nature and advantage of mechanically propelled vehicles will do more to bring about the coming displacement of the horse by the machine than all the articles which can be published anywhere.

The Development of Electricity.

THE recent address of Mr. A. W. Heaviside before the Newcastle Section of the Institution of Electrical Engineers, delivered at the Durham College of Physical Science, and published in *The Electrical Engineer*, constitutes a very complete review of the development of the modern practical applications of electricity.

Starting with the introduction of telegraphy in 1837 by the almost simultaneous inventions of Wheatstone and Cooke, Steinheil, Bell, and Morse, through the Hughes printing apparatus and the Wheatstone automatic system, the review, down to the cable and the telephone, Mr. Heaviside manages to cover this portion of the field very fully, yet in a most condensed form. In following the development of electrical methods of communication it can now be seen how naturally the successive inventions grew out of each other, and, with a few unfortunate exceptions, how each discovery falls into its proper place in what almost appears as a predetermined scheme.

Many of the practical details of space telegraphy are now seen to have been existent in connection with improvements in telephony, and the latest achievements which have been made in telegraphy across space are seen to be the results of the combined work of many minds, all contributing to the success which Marconi has attained, and which is by no means yet completed.

Historically and practically electric lighting naturally follows communication, and here Mr. Heaviside gives space to the work of Mr. Swan, who did for incandescent lighting in Great Britain what Edison did in America.

Coming to electric generation as a necessity in all subsequent work, the Parsons steam turbine is referred to as a prime mover, partly because of its relation to Newcastle industry, but largely because of its successful application to the driving of electrical generators.

So far as power stations go, we may well leave Mr. Heaviside to state the question in his own words; it cannot be better done:

"Suppose we build anew on the experience gained. Cease to put down what now may be considered toy machines all in a row, and tobacco-pipe chimneys, jealously watched by vigilant smoke inspectors catching the specks upon sheets of white blotting paper. Emulate the courage of the Americans, the Swiss, and the Continent generally. Don't adopt expediency, either

as to site or anything else; then that peace of mind which belongs to solid far-seeing work overtakes the engineer and his friend the capitalist. They may smoke the pipe of peace with the imperturbability of a Turk, and wait. It must come. Every house will eventually have its electric light, as it will have its telephone. Purity, steadiness, and convenience save its extra nominal cost over other illuminants now, and continuous production will reduce gas companies' dividends from lighting alone to something exceeding small by-and-by. Hence the future of the electrical engineer augurs happily—he, the maker of this good thing, who only the other day, and, alas! even now, is so lowly rewarded for his labours as not to be lauded by his neighbours.

"On the distribution side of the question there is a danger. A large central power-house, if there is to be economy, means high-pressure, alternate-current transmission of, say, 50 periods uniphase, if it will do (by no means improbable in the near future), and more phases if it will not, to as near the point of consumption as possible. Large low-tension services are to be deprecated, especially where coal is cheap. The fewer the transformations the better, and preferably of the static than of the dynamic order. In other words, do not have moving parts demanding human watchfulness, except where it is imperative, as for straight currents for electro-chemical work. Alternating currents needing no brushes will do all the rest. This may be rank wickedness to some trade interests, but it is the goal. Simplicity is what is wanted, not complication. There must be a point where the cost of long-distance transmission overtakes the economy of centralised production. That point has to be determined; our grandmother, the Board of Trade, will have something to say about that. We are not as free as the winds, as in Switzerland, where a dab of red paint on an insulator on a pole supporting multitudinous services marks sudden death if disregarded, locating as it does the extra high-pressure service, and where magistrates rightly treat the idle breaking of an insulator as a crime, thus acting for the public interest as the British Post Office does when a penny letter is stolen.

"Motive power by electrical agency is as convenient as going to the poulterer for your ducks, instead of keeping your own duckpond. It is this principle that makes for success with power work. Nothing can stop it. What so cleanly, so simple, as getting all that is needed by turning on a tap? No space is occupied by a steam plant, no capital locked up in its purchase, and no standing charges in its maintenance. There is no waste during holidays or strikes, and one care the less is borne by the user. This is the age of specialists, another name for the division of labour—without them the work of the world would not go on. Scatteration of effort is dissipation of energy. The user with the specialist at his elbow is relieved mentally, thus brain power is released for concentration on his own specialty."

Micro-Metallurgy of Steel.

THE microscopical study of the internal structure of metals is becoming of great practical importance, for it enables us to solve many of the problems which the ordinary testing methods leave unanswered, and helps to a clearer understanding of the underlying causes to which all the observed phenomena are due.

Recent issues of the *Zeitschrift des Vereines Deutscher Ingenieure* contain a communication from the Royal Testing Laboratory, at Charlottenburg, in which Herr E. Heyn describes some of his very thorough and interesting work in metallography. He says that researches in this field show clearly that metals and alloys in the solid state have an internal structure resembling that of rocks. We have long been accustomed to ascribe all mechanical changes in metals directly to molecular displacements, but metallography has thrown a new light on this subject. It shows convincingly that only in the rarest cases are metals and alloys homogeneously built up of molecules, but are rather a conglomeration of microscopic particles, which latter may be well defined groups of systematically arranged molecules. These groups of molecules are the structural elements with which metallography deals, and are conveniently designated as granules. Neighbouring groups in a metal or alloy may contain molecules of the same kind, whose arrangement from granule to granule may, however, be different. The various groups will then differ physically, but not chemically. It can also happen that adjacent granules are composed of different kinds of molecules, and they will then differ chemically as well as physically. It is the province of metallography in the first place to ascertain the number, the kind, and the properties of the individual groups, and then to determine the influence of these factors on the properties of the metal or alloy as a whole. Herr Heyn conducted the experiments described in his article with a view to getting an answer to the question: What changes are undergone by the individual structural elements of certain metals, when these latter have their shape changed when cold and are then subjected to high temperatures?

He confined his investigations to copper and low-carbon ingot steel.

The minute structure of copper and iron in the pure state bears a certain resemblance to the structure of marble. The latter consists of small calc-spar granules, whose surface is generally irregular, but which exhibit all the essential attributes of crystals. Pure copper consists of small granules of copper, pure iron is composed of small iron grains, which, in the language of metallography, are called ferrite granules. These granules are generally of microscopic dimensions, but are occasionally visible to the naked eye. Like the calc-spar grains in marble, they possess all the properties of crystals, even though they may lack the outward marks of plane surfaces disposed at constant angles with one another. Their bounding surfaces are more or less irregular, owing to the mutual inter-growth of neighbouring granules.

The most convenient way of showing that these granules do possess a true crystalline structure is by producing so-called etched figures on their surfaces. It has been found that when crystals are treated with an etching fluid, minute figures, geometrically regular, are formed on their surfaces. These figures are the same for similar surfaces of the same crystal, but differ for dissimilar ones. They are produced on sectional surfaces as well as at the outer natural ones, and they are infallible indications of crystalline structure, for they never occur on amorphous bodies. Now, if a polished metallic surface is treated with some appropriate fluid and it is found that these etched figures are produced on the granules, it follows that the

structure of the granules is crystalline. This is, in fact, the case, and the microscopic study of etched surfaces forms a very important branch of metallography.

Herr Heyn treats of his experiments on copper and steel at considerable length, and we shall have to confine ourselves to a few of the results he obtained in his experiments with steel.

As has been already mentioned, iron in its pure state consists of crystalline ferrite granules. When carbon is added, there is an instant change in the internal structure of the metal. About the boundaries of the ferrite granules a new substance is visible, whose quantity grows with the increase of carbon. It is found that this substance, which has received the name of pearlite, is an intimate mixture of thin lamellæ of ferrite and yet thinner lamellæ of a chemical combination of iron and carbon, Fe_3C, which bears the name of cementite. Low-carbon irons and steels are composed of a conglomeration of ferrite and pearlite, but when the carbon reaches about 0.8 per cent. the ferrite granules disappear, and only the pearlite remains.

In the low-carbon steels and in other metals and alloys where the crystalline granules form the larger part of the internal structure, it is of importance to determine the average size of these granules. Herr Heyn does this by etching a steel surface with copper-ammonium chloride, or with nitric acid. He fixes the boundaries of a large enough field of view, using a microscope of comparatively low magnifying power (100 to 350), and then, with a high magnifying power which brings out the etched figures clearly, the number of ferrite grains within the chosen boundaries is counted. The total area is found by means of a planimeter, that occupied by the pearlite substracted, and the remainder divided by the number of ferrite granules, which gives the average area of the latter. This surface unit serves at the same time for a measure of the average volume of the granules.

It is necessary in counting the granules to have a magnifying power high enough to bring out the etched figures, for otherwise it is difficult to distinguish the boundaries between adjacent granules. As these granules are arranged irregularly, they present dissimilar faces at the etched sections, and so the character of the figures varies from granule to granule and makes it easy to distinguish between them.

One series of experiments was made with a very-low-carbon steel wire, which consequently was built up largely of ferrite granules, with only a small proportion of pearlite. At all stages of the investigation, cross-sections of the wire showed a sharp demarkation between an outer light-coloured zone and a dark inner one, which were differentiated as far back as the original cast ingot. The sizes of the granules in these zones differed materially, the grains in the outer zone having from one-and-a-half to four times the area of those in the inner.

The material was in the form of a rolled rod of 5.2 millimeters diameter, and a 3.7-millimeter wire drawn from it. Sections of the original rod showed that the ferrite granules, speaking roughly, had the shape of cubes, or, at least, that their surfaces parallel to the axis of the rod were equivalent to those at right angles to the axis. But when the rod had been pulled apart in a testing machine, it was found that the granules near the break had been stretched out so that, although their volume remained about the same as before, their diameter in the direction of the pull was about twice as great, while their area at right angles to the rod's axis was correspondingly smaller.

When the 3.7-millimeter wire was examined after being cold drawn, the granules showed a considerably reduced volume. Their length in the direction of the wire's axis remained about the same as in the original rod, but their cross section was only about one-fifth as great as before. It follows, that, in the process of drawing, the original granules were broken up, and, consequently, that the number of granules per unit volume was greater after drawing than before.

When the drawn wire was subjected to a temperature of 417° C. for half an hour, there was hardly any appreciable effect upon the granules. When heated for the same length of time to 616°, however, there was a decided change in the length of the granules, it being reduced to about one-half, while their cross-section remained the

same. There must, therefore, have been a breaking up of the granules which had been previously subjected to the cold-drawing process. But there still remained a distinct stratification parallel to the axis of the wire.

When, however, the wire was heated for half an hour at a temperature of from 950° to 970°, there was a complete transformation in the internal structure. Every trace of the stretching or stratification vanished. The size of the ferrite granules had become entirely independent of that of the original grains in the drawn wire. This was shown by the fact that the granules in the new condition were larger, the slower the rate of cooling down from 950°. This indicates that there was a complete re-crystallisation of the material. After this, when the wire was again heated to about 600°, not the slightest change in the structure could be observed, which is remarkable because the original drawn wire underwent a structural change at this point.

The changes caused by heat in the form and size of the ferrite granules depend, therefore, upon the condition of the metal when heating begins. If the metal is in a strained condition, due to having had its shape altered when cold, a change will take place in the size of the granules at a comparatively low temperature. If, however, the metal is in its natural state, a thoroughgoing change will occur only above a fixed temperature (the crystallisation temperature), and any subsequent heating below this temperature will have no influence on the size of the granules.

Movable Conveyors for Blast-Furnace Charges.

Among the mechanical appliances for facilitating blast-furnace work in the United States is the inclined elevator, which conveys ore, flux, and fuel to the mouth of the furnace with a very small expenditure of labour. But this elevator is fixed, so that it can serve only one furnace, and in an extensive plant there must be as many elevators as furnaces. Besides, if an elevator gets out of order, its furnace is put out of blast.

In order to overcome these difficulties, Herr Fritz W. Lürmann proposes various plans in a recent number of *Stahl und Eisen*. In his first plan, the storage bins for ore, limestone, and coke are so arranged that the buckets can be run underneath and filled through sliding doors in the bottom of the bins. The buckets are then run on trucks to a travelling crane, which hoists them vertically and carries them horizontally to a second crane. This latter crane travels on a structure running over a row of furnaces in such a way as to command them all. Reserve cranes are provided for, in case of accident, so that there need be no interruption in the work of charging the furnaces. This method, however, is not strictly continuous, as it involves at least two changes, one from the truck to the first crane, and another from the first crane to the second. In the next plan, a single travelling and revolving crane is substituted for the two travelling cranes. This revolving crane takes the buckets from the trucks and conveys them right to the mouth of the furnace, and as it travels on rails parallel to a line of furnaces, it can take care of several.

The third plan goes a step further and provides for chutes in the sides of the storage bins, so that the buckets can be directly conveyed by a travelling and revolving crane from the place where they are filled to the mouth of the furnace.

A fourth project calls for a conveyor of the Brown type, but which can travel so as to command several furnaces and also reach all the storage bins.

The fifth plan is somewhat similar to the preceding, but involves the use of Hunt conveying and hoisting machinery with a long inclined cantilever travelling crane.

In all these plans the motive power can be gas, steam or electricity.

In this connection it is interesting to notice how much attention is now being paid by the Germans to labour-saving devices of all kinds, and particularly to hoisting and conveying machinery for materials. American apparatus and methods are being closely studied in Germany, and as a result are being widely applied.

Experimental Railway Work with High-Tension Rotary Currents.

In the wonderful development of the electric railway during the past decade the direct current has played by far the most

important part. In other fields the rotary or polyphase current has of late made marked advance, but heretofore there has been but little direct application of it to railway work. For short-distance railroads, and particularly for city trolley lines, the direct current possesses marked advantages. Where there are violent fluctuations in the load, as is the case with a trolley car making frequent stops and climbing sudden grades, the direct-current apparatus can be used to better advantage, and for the same service is lighter and cheaper than rotary-current motors would be. Moreover, the complicated nature of rotary-current wiring, both in the overhead network and in the connections aboard the car, prevents the direct use of these currents in city railway work. They will probably be employed to best advantage on trolley roads in an indirect way. High-tension polyphase currents will be generated at some place where power can be conveniently obtained, and will be transformed down by rotary transformers, at the points where they are to be used, into direct currents of comparatively low voltage. Some plants already employ this method, which has several points of superiority.

But it is in long-distance railway work that the rotary current has an opportunity to play a leading part. Here cars can make long, continuous runs at uniform speed, where the polyphase motor will appear to best advantage, and high-tension rotary currents can be economically transmitted on bare overhead conductors and taken off by sliding contacts attached to the moving cars. If the voltage be not too high, the currents can be directly supplied to the motors, but with very high pressures the currents will be transformed down by stationary transformers carried on the cars.

Some extensive experiments have recently been made with this system by the Siemens & Halske Company, near Berlin, and they are described in the *Electrotechnische Zeitschrift* by Herr Walter Reichel, the engineer in charge.

A standard-gauge track, 1.8 kilometers long, was laid along an unfrequented country road. There was only one curve, of 200-meters radius, on the main line, while there were two sharper curves on the branch leading to the power house and car sheds. The power house was situated about the middle of the line, and got direct current from an external source to charge a storage battery and run a motor, which, in turn, drove a rotary-current generator. The latter is a twelve-pole machine, the connections of whose winding can be altered so as to furnish pressures from 385 to 4,000 volts. It runs normally at 500 revolutions per minute, and the rotary current has 50 periods per second. There is also a transformer which can increase the electromotive force from 750 to 10,000 volts. This made it possible to conduct the experiments with three different line voltages:

1. 750 volts, which was used by the car motors directly.

2. 2,000 volts, which was also used without transforming.

3. 10,000 volts, which was reduced to 750 volts by transformers on the locomotive.

As the experiments were conducted on a public highway, it was necessary to place guard wires beneath the overhead conductors, so that the ordinary methods of taking off the current by underneath contact, either rolling or sliding, were not applicable. Two methods were tried. In the first the current was taken off by three horizontal arms extending from an upright post on the car and making sliding contact with the upper surface of the working conductors. This arrangement was afterwards abandoned in favour of the following: The three parallel conductors, of hard copper wire, 8 millimeters in diameter, lie in a vertical plane, 1 meter apart. They are supported on strong porcelain insulators, triple petticoated. Attached to the upper part of the line poles are pieces of iron, shaped like a long bow; on a flexible part of which, corresponding to the bow string, are fastened the insulators. The poles themselves are strong, latticed iron columns, firmly embedded in the ground to a depth of 1.9 meters, while those poles which have to withstand the side pull of the wires are surrounded with 1.5 cubic meters of cement. The poles are 40 meters apart on tangents, and closer together on curves, and each is carefully earthed by connecting it to the rails with stout copper wires, so that even if there should be any leakage of the high-tension current, the danger in touching the poles will be minimised.

The guard wires consist of four parallel galvanized-steel wires, 5 millimeters in diameter, connected at intervals of 1.5 meters by cross wires. They are supported by arms projecting from the poles, below the working conductors. Current is taken off the conductors by three stirrup-shaped wires at the ends of movable arms on top of the electric locomotive. These arms extend up sideways from the locomotive and are inclined at different angles so that the stirrup wires can press against, and make good sliding contact with, the working conductors.

The electric locomotive was built up on an ordinary railway-car truck with two axles. The total length of the locomotive, including the buffers, is 6.3 meters, the width of the platform 2.2 meters and its height above the rails 1.2 meters. The body of the locomotive is of sheet iron. The central part is occupied by the motorman, and has glass windows in front and behind, and doors at the sides. On the roof is the structure to which the sliding-contact arms are attached. The fore and after parts of the locomotive are lower than the central portion, and have inclined tops which can be lifted up. They contain the transformers, resistances, high-tension switch, and air compressor. The whole locomotive is of metal, and all the parts are well earthed. The total weight of the locomotive, completely equipped, including the motors, is 16,000 kilograms.

There are two rotary-current motors, one on each axle. The ones used in the third series of experiments, with a line pressure of 10,000 volts, were designed for a voltage of from 650 to 850, and had each a normal output of 30 horse-power, which could be increased to a maximum of 120 horse-power at 650 volts. The electromotive force of the line current is reduced from 10,000 volts to 750 volts by the stationary transformers placed in the ends of the locomotive, and the current is then led to the motors through the controllers, which are designed so as to allow several variations to be made in the speed and in the power.

The experiments were decidedly successful. A speed of 60 kilometers per hour was reached when hauling a load of 30 tons, and it was demonstrated conclusively that it is practicable to take current from the line at pressures up to 10,000 volts and use it, after transforming down, for driving motor cars. The apparatus used proved thoroughly reliable, and can serve as a guide for future practical work.

Aluminothermie.

WHEN aluminium and oxygen enter into chemical combination, there is evolved a higher temperature than can be generated in any other artificial way except by electrical methods. For a long time this fact was not generally recognised, partly because aluminium was more or less of a chemical curiosity and its production was confined to the laboratory; but of recent years, since it has become an important technical product, its properties have been more widely investigated and new facts concerning it discovered.

The work of Dr. Hans Goldschmidt in this field has laid the foundation for an important new industry, to which the name of "Aluminothermie" has been given. This term covers, in general, those processes in which high temperatures are produced by the combination of oxygen and aluminium, and various developments of Dr. Goldschmidt's inventions are described by him in a recent issue of *Glückauf*.

The chemical reactions involved are very simple. Oxygen is not taken from the air, but is used as combined with the metals in the form of metallic oxides. As an example, take iron oxide, of common occurrence in nature as some of the iron ores. If metallic aluminium, finely divided, be mixed with a powdered iron ore and a reaction made to take place, the resulting products will be aluminium oxide and metallic iron, and at the same time a very high temperature will be evolved.

The problem has been to start the reaction. Most of these mixtures of metallic oxides and aluminium will burn only at high temperatures. They could be stirred with a glowing rod without any combustion taking place. The application of external heat would not answer, because the heat which would cause the mixture to burn would damage the crucible containing it.

A solution of the difficulty was reached when it was found that there is a class of oxides, which, when mixed with aluminium,

are easily ignited at a low temperature, and after ignition evolve very high temperatures. It is only necessary, then, to sprinkle an easily inflammable mixture, such as barium superoxide and aluminium, on the refractory one, and then light the former, which can be done most easily with a large match. The kindling mixture will burn and generate a high temperature, and so set the main mixture on fire. More of the latter can be added from time to time, as desired, and will react with the evolution of as high temperatures as the combustion of the first portion generated.

There is thus afforded an extremely convenient means of obtaining great heating effects at any place, without the use of machinery or any complicated apparatus. The temperatures resulting from the reactions described can only be estimated, as there are no means of determining them exactly, but they are considerably over 2,000° C.

The practical applications of this process already embrace wide limits. A direct result of the chemical reactions is the separation of the metals from their oxides in a pure state. The combinations take place in a regular way, according to chemical laws, but the mixtures are always made with an excess of oxide, so that all the aluminium will be oxidised and no metallic aluminium left to form alloys with the other metals.

The process is applied with special advantage to metals which it has not before been possible to isolate completely, but which now can be separated in an entirely pure state, free from even carbon. Among such metals, one of the most important in a metallurgical way is chromium. Almost all the chromium which has heretofore been used in steel metallurgy contains a considerable percentage of carbon, and is to be regarded as chromium carbide. All the chrome steels are, therefore, strictly speaking, chromium carbide steels, and have their properties materially influenced by the combined carbon. But it is now possible with the pure chromium to form steel alloys whose properties are decidedly different from the old chrome steels, and which can also be made to contain larger percentages of chromium.

In the same way pure manganese is produced, which finds a wide application in the making of manganese bronzes, free from iron, and, also, in special manganese steels. This pure manganese possesses the desirable property of not disintegrating on exposure to the air, as does the ordinary carboniferous manganese, and it also particularly distinguishes itself by its easy formation of alloys with molten copper, tin, zinc and other metals. Copper alloys containing 20, 30, 50 and even higher percentages of manganese are formed with extreme ease by the pure manganese.

Among other metals of growing importance in metallurgy which are prepared by this process may be mentioned titanium and boron.

A most important bye-product is the melted aluminium oxide, which is formed simultaneously with the separation of the pure metals. This product is really an artificial corundum and has been called "corubin." It is distinguished by its great hardness, and for grinding and polishing purposes far surpasses natural corundum and emery.

But perhaps the most important practical application which is made of this process is in welding. For this purpose there is used a mixture called "thermit," consisting essentially of iron oxide and aluminium, which is kindled by one of the easily burning mixtures previously described, and burns with the evolution of great heat in a specially prepared crucible made of corubin, magnesia, or some other very refractory material. The surfaces of the parts which are to be welded are carefully cleaned and polished, and pressed together by a framework with screws. A mold is placed around the joint and into it is poured the fluid mass from the crucible. The heat and pressure do the rest. In the crucible, before pouring, there are two strata. The lower consists of fluid iron and the upper one of the lighter melted aluminium oxide. When the pouring begins, the alumina which first flows into the mold quickly cools and forms a thin layer on its inner walls as well as on the pieces which are being welded. The rest of the alumina and all the iron remain fluid for a short time in the mold. In consequence of the solid coating of alumina, the molten iron does not touch the surfaces of the mold and the welded piece, and when the whole mass has cooled down, it can be removed by a couple of

light hammer blows. The welded piece has not been deformed by the attachment of any fused iron, and the mold is not injured and can be used repeatedly.

By many experiments it has been carefully determined just how much of the heating mixture is necessary for a weld of a given size, and what the capacity of the mold must be. In this way it is possible to know beforehand the amount of heat required for a weld. This is an advantage which no other welding process possesses, as these are all based on empirical methods and require an experienced eye and hand to be carried out successfully. The new process can be applied by ordinary workmen, after a very little practice. Another advantage of the new method is that the heat is concentrated just at the place where it is needed.

This process is particularly applicable to rails of electric railways and to pipes for steam, gas and water, as these can all be welded in any position and at the places where they are in use.

The molten iron can also be used to repair defective or broken parts, by casting it right on to the original piece and working it into proper shape after cooling.

Only a few of the leading applications of this process have been here given, but there are enough to show that it bids fairs to mark a distinct advance in metallurgical fields.

The Poulsen Magneto-Telephonograph.

THE telegraphon, or magneto-telephonograph, an invention of the Danish engineer, Valdemar Poulsen, makes use of the fact of permanent magnetism to record tones and sounds in a simple manner, so that they can be reproduced whenever and as often as desired.

The inventor proceeded from a well-known phenomenon: If a magnet be drawn over an iron or steel plate, the intensity of the permanent magnetism will be altered at all the places so touched. This can be readily shown by sprinkling iron filings over the plate, when they will arrange themselves in the path which the magnet has followed.

This phenomenon gave Mr. Poulsen the idea that it must be possible to record magnetically the changes in the core of a telephone on a steel wire moving past the telephone magnet pole. If this wire, which has been thus permanently magnetised in a direction perpendicular to its axis with an intensity varying from point to point, be then moved before the pole of a small electromagnet, it will induce currents in the coil of the latter. These currents, when led to a telephone, will there cause the original sounds given out by the first telephone to be reproduced.

Experiments confirmed the correctness of these views, and, after two years' work, the idea has been embodied in a simple apparatus which meets the requirements of every-day practice.

In one form of the apparatus there is a cylinder about 14 centimeters in diameter and 25 centimeters long, on which a steel or nickel wire, 1 millimeter in diameter, is wound in a spiral groove. Resting on a bar and directly over the spiral wire is a small double electromagnet, whose core consists of a soft-iron wire 1 millimeter in diameter. The poles of this horse-shoe electromagnet are pointed and brought near together on opposite sides of the spiral steel wire, which they almost grasp. While the sounds are being recorded, the cylinder is revolved by clockwork or an electromotor, and at the same time the electromagnet travels along its supporting bar. The coil of the electromagnet is in circuit with the secondary of an induction coil, whose primary is connected with a microphone transmitter and battery. As a preliminary step, the spiral steel wire has been already uniformly magnetised at right angles to its length by this same electromagnet in circuit with a constant battery. If then, the microphone transmitter be spoken into while the cylinder is turning, it can be seen that the varying current in the electromagnet will cause the permanent magnetism of the spiral wire to be strengthened at one point and weakened or even reversed at another.

When the same electromagnet is afterwards connected with a telephone receiver and moved along the spiral wire, the varying permanent magnetism of the latter will induce, in the magnet coils, currents which, led through the receiver, will cause the original sounds to be reproduced.

Experiments have shown that speech can be thus reproduced 1,200 times without

weakening the original impression. When it is desired to wipe out a record, the electromagnet, as in the first instance, is attached to a constant battery and run over the wire, thus magnetising it uniformly once more and preparing it to receive a new message.

A cylinder, such as described above, will record a conversation lasting only about a minute. When longer conversations, of from ten to fifteen minutes' duration, are to be recorded, there is employed a modified form of apparatus, in which a steel ribbon, 3 millimeters wide and 0.05 millimeter thick, takes the place of the spiral wire and cylinder. The steel ribbon winds off one axle and on to another, like the paper tape of a printing telegraph, passing close to the recording electromagnet on the way. A third modification is used to distribute news by telephone. A rather short, endless steel ribbon, about 4 centimeters wide, revolves continuously around two axles. It first moves by the recording electromagnet, then past a large number of transmitting electromagnets and finally past a wiping-out electromagnet, which removes all traces of the record and prepares that portion of the ribbon to receive a new impression when it again reaches the recording electromagnet.

Each of the transmitting electromagnets is connected with a receiver belonging to a subscriber to the telephone "newspaper."

Mr. P. O. Pedersen, who has been associated with Mr. Poulsen in the development of the telegraphon, has perfected a very ingenious device by which two conversations can be either simultaneously or successively recorded on the same wire, or ribbon, and afterwards clearly reproduced without interfering with each other. He simply uses two electromagnets instead of one. The two are placed close together and have their coils connected in series. In the first place, a conversation is recorded just as described before, except that there will be a duplicate record, corresponding to the two electromagnets. The connections of one of the electromagnets are then reversed, so that the current flows through it in the opposite direction, and another record is taken. The two electromagnets now produce opposite effects. While one strengthens the permanent magnetism of the steel wire, or ribbon, the other weakens it, and vice versa. This record is made right on top of the first. In order to understand this more clearly, take a point of the wire, *a*, between the poles of the first electromagnet, and another point, *b*, between the poles of the second. In the first case considered, when the polarity of the electromagnets is the same, the permanent magnetism of the wire at *a* and *b* will be strengthened at the same time, or weakened at the same time. But in the second case, where the electromagnets have opposite polarities, the magnetism at *a* is being strengthened while that at *b* is being weakened, and vice versa.

In order to reproduce the first record, the electromagnets are connected just as they were when it was made. They will then be influenced by the first record, while the second will produce no effect, because, owing to the opposite magnetisations at *a* and *b*, opposite currents will be induced in the two electromagnets and will neutralise each other. When the electromagnets are connected in the second way, however, they will be influenced only by the second record, the magnetisation due to the first record now inducing opposing currents in the reversely connected coils.

The same general arrangement is employed for sending two messages simultaneously over the same wire in the same direction. At the sending station a transmitting electromagnet sends the combined records to the receiving station, where they are recorded again. Each record is there selected by an appropriately connected pair of electromagnets.

This general description, taken from the *Electrotechnische Zeitschrift*, shows that the theory of these methods is clear and simple. It appears rather remarkable, though, that the quantitative effects of the permanent magnetism are great enough to produce good results, but the work done so far gives great promise that a real improvement has been made in telephony.

REVIEW OF THE AMERICAN PRESS

Central-Station Economies.

IN an interesting and very clearly put paper before the National Electric Light Association, published in full by the *Electrical Review*, Mr. W. L. Abbott deals with "Operating Economies in Central-Station Practice"—with the work, that is, which comes into the field of the manager rather than that of the designer of the electric power house.

He alludes appreciatively at the outset to that freedom in imparting information which has been said to be characteristic of American works, as a chief factor in the rapid improvement in operating details now under way. Local conditions must largely control the methods adopted in any particular station, but free interchange of experience and readiness to make trial of new ideas furnish the material out of which "natural selection" will evolve "the unwritten code of rules" for the special instance.

Perhaps the most important methods set forth by Mr. Abbott are those which he reserves for the latter part of his paper, and which deal with the management and control of the station labor. The problem for the manager is so to arrange the pay roll and operating force "as to get the maximum results with the least expenditure of money." This requires that the force should at all times be adequate for the work required, that wages should be carefully graded according to duties, skill, and responsibility imposed, and that the return to the workman should include an element of incentive and expectancy of promotion, unmarred by favoritism and petty works-politics.

The division of the force into a night gang and a day gang, once quite general, Mr. Abbott finds ill-adapted to central station requirements. The hours are too long, the distribution of labor is not the best, and the system is too inelastic. "The number of men in the station does not vary according to the load. The practice which we instituted several years ago, of bringing the men on one or more at a time, an hour or so apart, and letting them off in the same way, we find can be made to meet exactly the requirements of an uneven load, and enables us to rotate the different men of the same class through all the different shifts during the course of one or two months, thus making the work and hours of all exactly alike in the cycle. At the end of each week the schedule is made up for the week to come, for each of the different classes of operatives interested, and this is posted on Saturday night so that as the men go off work on the following Sunday it is known what shift each will have during the coming week. These schedules are altered from week to week * * * to conform with the varying conditions of the load curve."

Thus, taking a typical day, the plant starts at midnight with five men—rather more in proportion than the day force, on account of the variable nature of the night load. At six the load begins to pick up, and the force is increased by one man each at six, seven, and eight o'clock, by which hour eight firemen are at work. This number is maintained until one o'clock, the noon drop being availed of for cleaning fires, eating dinners, and securing a breathing spell. Another man comes on at one, a tenth at two, and, anticipating the four o'clock maximum, three men come on at three and the last one at four, by which time fourteen are at work. "After five o'clock the load gradually declines until midnight, when it is only about one-fourth as high as it was at five. Owing to the way in which the men have been brought out, their shifts are finished so that the force is automatically decreased in proportion as the load decreases." Of course, the scheme as given above deals only with net changes, ignoring mere individual replacements not affecting the total number. Altogether twenty-one firemen have worked

during the day, handling about 210 tons of coal, and the force arranged for gives at all times an excess of one or more men. The load curve and the "firemen's curve" for a specimen day show a really remarkable correspondence.

Next to providing the force comes its supervision. Mr. Abbott points out that study of the conditions of combustion in the furnace may easily effect a saving fourfold greater than can be made by final refinement of the indicator card. A fireman will normally burn fuel costing ten or fifteen times as much as his wages. By no sort of driving can half his wages be saved, but by proper watching and instruction he may easily be made to save double his wages in coal. The fuel itself should be selected to give "the greatest amount of combustible for the least amount of money, provided the furnaces are of the proper kind, and ample in capacity to make the required amount of steam." Next comes its proper combustion, and here the greatest aid may be given by the now easy process of flue-gas analysis, especially the determination of the percentage of carbon dioxide. Under perfect conditions, this may run up to 20 per cent.; in practice it often runs as low as 2 per cent.; of course, on account of excess of air through careless firing or through running the boilers on too light loads. Mr. Abbott has found great advantage from the use of the econometer, " a device * * * through which is induced a small current of gas from a boiler breeching. The weight of this gas, changing with its composition, moves a pointer across a dial." He gives some very interesting and amusing curves showing the close relations between boiler efficiency and carbon dioxide percentage, and the influence of surveillance upon firemen's efficiency.

The other points dealt with in his study are the saving and renovating of waste and the use and recovery of lubricating oil. For the former, he finds greatest advantage from the use of a good quality of waste, first on the finer parts of the machinery and then for coarser work. After this it is put through a washer consisting of a train of rolls over which hot water is running, and then dried in "a sheet-iron box 30 inches square and 6 feet high, filled with shelves one above another, made of wire netting and spaced about 10 inches apart," all being heated by a steam coil and relieved of vapor by a galvanized pipe leading to a boiler breeching. Two hundred pounds of damp waste can be dried thoroughly in a few hours. From 100 pounds oily waste, 40 pounds of oil and 40 pounds of dry waste are recovered. The issue of new waste is limited to three quarters of a pound per shift for a 1,200 horsepower engine, but the oilers are allowed all the washed waste they want. It is somewhat harsh and knotty, but more absorbent than new waste.

The recovered oil is purified by triple sedimentation, overflow, and drying. The admixture of cylinder oil makes it "better than new (lubricating) oil."

In cylinder lubrication, Mr. Abbott favors the adoption of "the oil which will give the best results in the high and let the low be content with what it gets."

As he says in his summary, some of these details may seem trivial, "but when we consider that $100 saved is $100 added to the surplus, which is as good as $500 increase in gross earnings, and that to add $500 monthly to the gross earnings would require an investment of, say, $25,000 * * * we may realize what a valuable asset is an engineer who is prolific in methods for keeping costs down or is ready to adopt such methods from others."

Foundry Management.

It is rather strange that while machine shop management has formed the subject of so much study and discussion, foundry management, comparatively speaking, has suffered from almost complete neglect. It is the more strange because very often shop and foundry form twin members of one plant. It is true that the United States affords examples of advanced foundry management, which seem to leave nothing to be added in the direction of system, economy, productiveness, or cheapening of output—witness the Westinghouse air-brake works at Wilmerding; but how often, on the other hand, the visitor to the American machine works of the first order is led from a machine shop full of the latest tools, operated by the most advanced methods, and ushered into the foundry with the apolo-

getic remark, "Our foundry is very old-fashioned."

Mr. James A. Murphy's paper on Foundry Management, read before the American Foundrymen's Association and published in *The Iron Age*, deals with the matter very practically. The first prevailing fault he attacks is darkness. The "sunny side of an old oil torch" is a poor helper; "rough and bad castings can often be traced to bad light"; "light and ventilation are all important to success in the foundry." Mr. Murphy proposes, as a ready remedy, to have a section of the roof made of wire-glass, and by thus admitting daylight to avoid becoming "every day large and indirect contributors to the scrap pile."

He considers next labor and superintendence. The cursing, bulldozing foreman not only creates so much confusion about casting time that one-third of the work is likely to be lost, but drives away good men and incites time-killing among those who stay. "A man of broad experience, good education and address, temperate in habits and language, firm and polite in his demeanor, generally is a student of human nature and has executive ability of a broad-gauge character * * * and is sure to produce the very best paying results." Coming down to the molders, a very general source of loss is the morning hour spent pulling out castings, cutting sand, mixing facing, etc., and the other hours lost during the day "skirmishing around after gaggers, parting sand, rammers, brushes, riddles and fixing up old flasks that should have been fixed before the job was given out." Laborers should do all this work. The saving in wages thus to be made, in a foundry employing fifty molders, would pay a good foreman.

Materials—especially sand—are of great importance. "About the first thing a new molder will ask his partner when he starts in a shop is about the sand. If told it is bad, he invariably spends more time on his mold." And, with all the extra expense of time and labor, scabbing may occur. "The difference in price between good and bad sand is very little, but the difference in results, if figured up, would be astounding."

Drying should be better understood. It costs a little, but castings are rarely lost in dry sand, and "a better and stronger casting goes a long way in compensating for the little extra cost."

Great attention is paid to iron, and yet, after paying for good pig and devoting a lot of time to compounding mixtures, poor results often follow through failure to give attention to the quality of the fuel. Cheap facings are another expensive economy. It takes more time to slick up a mold with them—even if it can be done—castings are harder to clean, and on heavy work a bad job results from fused sand.

Tools receive Mr. Murphy's attention in closing. "To get the maximum amount of work, or to expect it, a man should have access to tools without looking around the shop for them or waiting till some one else is done. Every molder should have at least a good shovel, two riddles, a pail, a brush and a rammer." He should be held responsible for these, aided by assurance of discharge to anyone stealing them. The other things, clamps, gaggers, rods, weights, etc., which can be made with scarcely any expense to the shop, should be furnished in plenty, so no one would be tempted to hide them for safe keeping, or need spend valuable time hunting or waiting for them.

Broad views, system, and attention to the importance of apparently little things are as important to success in the foundry as they are elsewhere.

Mining Opportunities in Siberia.

THE sensational gold discoveries in far northwestern America, and the rapid extension of American interests to the western shores of the North Pacific Ocean, have acted to turn the eyes of the mining world of the United States upon the yet unopened territory of Siberia, as possibly affording new worlds to conquer. In view of the diverse and often extravagant items of misinformation appearing in the daily press, it is of importance and value to secure information so definite and so conservative as that contained in the *United States Consular Report No. 754*, combining three documents relating to Siberian mining concessions. The first is a copy of the official communication to the Secretary of State from Count Cassini, Russian Ambassador, stating that the "exclusive right to exploit the mineral wealth in the Peninsula of Tchoukotsk" has been granted "to Colonel

Vonliarliarsky, of the Russian guards. The gentleman has organized an expedition under the direction of Mr. Bogdanovitch, a mining engineer, which sailed from Russia April 18-May 1." This expedition "is alone authorized to carry on mining operations in the country." The other two papers making up the report are communications from Commercial Agent Greener, at Vladivostock. They seem to be well informed, if not highly encouraging.

"Mining of all kinds in Siberia," Mr. Greener says, "has hitherto been beset with so many difficulties as to discourage operators, native or foreign. The concession to an American—D. M. Clarkson—to mine for gold or coal on his own account, without the usual adjunct of a Russian partner, seems to point to a more liberal policy. Still, there are restrictions." "Work must be done under disadvantages which would be hardly tolerable to ordinary American prospectors. For example, one must have special permits from local authorities for felling trees, and there are certain rules to be followed when minerals other than those specified in the grant are found."

The mineral wealth of the region has been for years practically untouched. "Much small capital has been exhausted in simply discovering that there is mineral wealth." The Chinese have worked and are still threshing over gold sands. Good specimens of coal are shown. Belgian, English, French and American experts have lately visited the country, and advised the formation of exploitation companies, but "prudent foreign companies withheld the capital, mainly because of government restrictions."

A coal bed 6 miles square lies only 31 miles from Vladivostock. It is an excellent quality of semi-anthracite, smokeless, valuable because of the marine market at Vladivostock. A French company tried to buy the mine in this area, but withdrew on account of the terms imposed. A similar result followed the efforts of the same company to buy a mine 16 miles from Vladivostock and 2.6 miles from the railway, where there is a basin of nearly 8 square miles of good steamship coal.

Several iron mines have been reported, lead and zinc are frequently found, and copper occurrences are plentiful, but no serious attempts at surveys have been made.

Quartz gold mines on Askold Island, near Vladivostock, are worked to good profit by a Russian firm, but Mr. Greener thinks "it should be honestly said, without any disparagement to the future of Siberia, that it is no special place for Americans. Those who came here twenty-five to thirty years ago did well, but all had either Russian partners or married Russians and identified themselves with the country."

He gives some idea of the obstacles to be met in the following summary: "With regard to gold mining privileges, the applicant must make petition in person here, or he may go to St. Petersburg if more convenient. In the latter case, the imperial authorities would refer the matter to the governor general here before deciding the case. In no instance would such a permit be hastily granted, and an applicant without references as to character and ability to carry out his plans would undoubtedly be rejected. The government also exercises strict espionage in matters of passports, permits, etc., and there is a high tax on melting and conveyance from the mine to the government office."

"The government advances no money to miners or manufacturers of any kind, except to those coming within the scope of its administrative policy. It does assist immigrants after they have arrived, but does not pay their way. It buys the output of all mines, on broad grounds of governmental policy, as it controls mining business of whatever character. But this fact would afford little 'stability' to the venture of any American who came to Manchuria or the Maritime Province to engage in mining without a special permit, or a Russian partner, or a good supply of capital and abundant machinery."

Even more valuable is Mr. Greener's second communication, giving translation and condensation of a French compilation of the Russian laws on gold mining, accurate to 1898. He conceives it possible that some slight changes in the way of contemplated reforms may be already in operation, though he has no notice of them. Space permits only a few extracts:

"To acquire the right to prospect for either alluvial or quartz gold, all persons or companies must procure a special permit on stamped paper, issued by the depart-

ment of mines. Permits contain no time limitations and are not transferable. A declaration in writing must be made to the police department of the locality where operations are proposed. The locality must be designated, as well as names of men belonging to the prospecting party, the date the expedition is to set out, and the place of departure. The passport and papers of each person must be accurately set forth. The cost of advertising the permit in the local press must be paid. In free territory, prospectors are entitled, so far as placer mining is concerned, to occupy an area of 5 versts (3.3 miles) in length, and in breadth the width of the valley in which operations are conducted; in quartz mining, to an area within a radius of 1 verst (0.663 mile) from a post bearing the date when prospecting began, and the name of the individual or company. After the post is set up, the right to prospect continues as long as the party stays on the tract so marked out. Should the ground be found sufficiently rich to be worthy of 'a request for a location,' at least two shafts must be sunk, demonstrating the presence of gold, and 'location posts' in place of the 'prospecting posts' must be set up.

"When a deposit is ascertained to be capable of being worked, a declaration of the fact must be made, in the form prescribed in paragraph 454, mining code (French edition), at the office of the chief of police in the district where the discovery is made. One copy of the declaration must be sent by the applicant for the location, within three months, without fail, to the chief office of mines, for publication in the local press; another copy goes to the district engineer, to be recorded in the register of applications for concessions. The copy sent to the chief office must be accompanied by a sum sufficient to pay expense of publication in the local press.

"In eastern, as well as in western, Siberia, the total length of a placer allotment must not exceed 5 versts (3.3 miles) in length, calculated from the 'indicator posts'; in breadth it may comprise the whole valley to the extent of 250 sagens (1,750 feet). An allotment granted for a gold bearing vein may be of any dimensions, provided its area does not exceed 1 square verst and the breadth is at least a third of its length.

"The same individual and company cannot receive two adjacent concessions; after one allotment has been obtained, a second cannot be granted except at a distance of at least 5 versts (3.3 miles) from the first. Holders of adjacent lots, however, are permitted to associate themselves into companies after the concessions have been granted.

"After the request for location has been granted the land may be cleared, the preliminary work undertaken, a more minute examination may be made, and actual working begun as soon as the documentary concession is in hand.

"The Russian mining code has two kinds of tax:

"(1) Land dues, calculated pro rata on the superficial area of the lot, payable from the date when the deeds granting the concession were received; due for the current year on December 31, and subject in case of nonpayment to the addition of a fine of 10 per cent.

"(2) Taxes in kind, based upon the amount of pure metal (gold or silver) extracted and deducted in the laboratories.

"In addition to the land dues and tax per pood (36.112 pounds), there is charged for the transportation of the gold to St. Petersburg: From Irkutsk, 46 rubles ($23.69) per pood; from Tomsk, 33 rubles $16.99). The conveyance of the gold in sealed sacks from the mines to the district office of the mining police and thence to the Department of Mines, is at the expense of the mine owner. In this province (Maritime), the charge is 150 rubles ($77.25) per pood.

"The operator must bear the cost of melting down the gold. The fee, by the new regulation of February 3, 1897, is uniform—42.315 rubles ($21.79) per pood of pure gold."

Mr. Greener, however, points out an opening for Americans in a line in which, as experience elsewhere has fully proved, they particularly excel: "The best chance for Americans here is in the line of mechanical work. A well-equipped machine shop, with competent American artisans and specialists in certain industries, would do well in Siberia; but no American without capital or special skill in his own trade has any business here."

Heavy Motor Vehicles.

THE advantages of mechanical propulsion of goods-carrying vehicles are clearly so great—so much larger even than those of automobilism of pleasure carriages—that it seems strange that the light-passenger wagon should have been the one to develop the more rapidly.

It is perhaps due in part to the tremendous impulse given to personal transportation by the bicycle, and in part to the circumstance that results acceptable to seekers after novelty, sport, or luxury were possible of attainment sooner than those which must stand the most rigid comparative tests as to mechanical efficiency and commercial economy. However that may be, the passenger automobile is an accepted and rapidly-increasing institution and the greater interest of inquiry now seems to center in the lorry, or automobile wagon for heavy duty, in the development—or at least the use—of which the United States seem relatively backward. The *Scientific American Supplement* takes up the description of the principal competing lorries in the Liverpool Self-Propelled Traffic Association's trials, and Mr. Arthur Herschmann, mechanical engineer of the Adams Express Company, presented a paper at the recent meeting of the American Society of Mechanical Engineers, embodying data and conclusions reached in his study for that company of "The Automobile Wagon for Heavy Duty." Mr. Maynard's articles in our August and September issues give a comprehensive view of the British field.

Mr. Herschmann points out that many of the disadvantages urged by its opponents—danger in crowded streets, damage to road surfaces, smell, risk of accident—are fully as great, if not much greater, in the case of horse-drawn wagons. The automobile takes less space, is controlled by the single brain of the "driver," and (the nucleus of the entire question of safety) can be far more powerfully and surely braked. "A load of 3 tons on a motor wagon running at the speed of 8 miles, could be pulled up in 8 yards—a performance which could never be obtained with horses."

Mr. Herschmann then takes up the various propelling agencies, beginning with Ericsson and Tangye's steam wagons and following with electric, compressed air, oil-engine, and, finally, the newer steam-motor vehicles Electricity secures cleanliness, ease of operation, fair flexibility in power and speed conditions, and answers the requirements of smooth city roads; but on rough roads the punishment is heavier than the battery can stand, the dead weight is large ("the best traction cell has only a capacity of about 7 watts per pound of its weight"), battery maintenance is a serious item, and "at this phase of the evolution the battery makes the electric truck an impossibility."

Compressed air, with all its promise, still requires a revolution in the construction of light storage tanks; it has the disadvantage that pressure falls as the air is drawn from the storage tanks, and weight for weight is less readily adaptable than electricity.

Carbonic acid has similar defects, besides high cost. Illuminating gas, giving one horse power for each 18 cubic feet at normal pressure, would give larger radius of operation—the same quantity of air at 200 pounds' pressure being requisite for the same power; but it seriously complicates the mechanism.

Oil motors, Mr. Herschmann thinks, have as yet given "no important results" as regards freight vehicles. The inherent difficulties he defines as: lack of ample power in an emergency; a horse, at starting, is said to develop momentarily 14 horse power—some say even more; the oil motor will not start under load and cannot well be designed to vary in speed, at least not in a wide range; clutch and gear mechanisms are requisite for starting and for adapting it to the constantly varying speed requirements of the wagon, and these give rise to trouble on account of the impact of the moving masses. Non-reversible, it is by no means a flexible motor. Finally there is the evil-smelling exhaust, and (in goods service) the chance of damage therefrom.

The steam wagon he finds superior to its competitors because:

"1. It has the greatest load and mileage capacity, or, in other words, radius of action.

"2. Its operation is independent of charging stations, and supplies necessary for the operation of the wagon can be easily procured and taken aboard quickly."

With an electric wagon expense becomes prohibitive as soon as a certain ton-mileage is exceeded; the oil wagon has no such limitation, the objections being in difficulty of operation; the steam wagon is in an entirely different position, as "the weight of machinery to be carried does not grow even in an arithmetical ratio to the carrying capacity."

About one-half of Mr. Herschmann's paper is taken up with discussion of the construction, which can be only summarized by his conclusions, leaving the readers who are interested to consult the original paper for his argument. Rubber tires are unsatisfactory for commercial wagons designed to carry one ton or more; steel tires, properly applied to stiff wooden wheels, stand more work and strengthen the wheels; springs of ample proportions should be relied upon to lessen shock. The total width of tires in inches should be at least twice the number of gross tons, for small wagons (two tons net load), this coefficient of two diminishing to one or even less with very heavy wagons.

Small driving wheels are recommended by greater safety under the severe strains; otherwise larger wheels (4 foot instead of 3-foot) would be preferable, as giving "a more powerful starting torque" and saving the driving gear.

The advantages of front driving are "more than outbalanced by the disadvantages introduced in connection with awkward location of machinery." Steering by fifth wheel, while apparently better adapted for heavy work, is in reality not as satisfactory as steering with pivoted axle ends. Spur gearing is preferred to worm and worm-wheel, because it does not lock the gear and causes less strain on striking an obstruction. Great improvement is possible in connection with the compensating gear or Jack-in-the-box, linking the driven wheels. The transmission between engine and rear wheels can "only be reliably effected by means of accurate spur wheels immersed in an oil-bath. A speed-reduction gear, best provided by means of two sets of spur wheels of varying diameter, one set stationary, the other movable axially on a square shaft, forms a desirable adjunct to the mechanism."

Boiler desiderata are safety, small proportions, quick steaming, and economy. Preference is given to shell boilers. A superheating device, well applied, is of great advantage. In addition to the engine feed pump there should be a second steam-driven pump. The small injector has not yet been made to give satisfaction on a wagon.

Firing can be easily effected by an oil burner, but coal and coke are preferable and cheaper. Condensers are not approved. The difficulties connected with smoke have been quite overcome.

Compound engines have so far been universally used; a light, well-designed, quick-revolution engine, fitted with reversing gear and with means for admitting high-pressure steam to the low-pressure cylinder will always answer. The cylinder ratio should be larger than in stationary practice, as the pressure is higher and a large low-pressure cylinder means a powerful starting moment under live steam.

Generally speaking, Mr. Herschmann finds the wagons constructed far too light to stand the severe strain of their work. The cost of propulsion per gross ton is not so important as to warrant sacrificing durable construction. His paper is accompanied by designs of steam trucks and tables of operating costs, deadweights, and carrying capacities, and concludes with very practical suggestions regarding the separating of repair work from the actual operating or "driving" of the wagons.

Concrete Steel in Dry-Dock Building.

THREE years ago, when Mr. Foster Crowell was bringing out his articles on Modern Wharf Improvements and Harbor Facilities in this magazine, he made sharp comment upon the apathy which was responsible for the poverty of the United States in docking facilities.

Territorial and consequent naval expansion, and the revival of American ship building, which has been the topic of several articles in our recent issues, have concentrated much-needed attention on the improvement of docking facilities around the United States coast. Private enterprise is active—witness the work at Newport News referred to in our July number; and the prevailing interest is reflected in the current engineering press. *Engineering News* gives a large plate and a full, though condensed, description, from the *Annales des Ponts et Chaussées,* of the new Toulon dry dock with steel caisson foundations, and the

Engineering Record leads a recent number with an editorial on dry-dock construction, taking the Toulon dock and the great concrete dock at Liverpool as texts for a commentary upon the use of concrete and of concrete steel for dry-dock work.

The Toulon case is a quite remarkable instance of the use of the pneumatic caisson with dimensions far in excess of those usually employed. The underlying strata at the proposed site were two dissimilar layers of pudding stone, the upper, through which the excavation was to be made, being the softer, but quite intractable and permeable by water, and water-laden from inland drainage and from the harbor waters. Three plans were submitted by contractors: Excavation and masonry building in the clay, within a cofferdam—rejected because the authorities believed it would be impossible to deal with the seepage; use of ten smaller caissons—one for the entrance, one for the bottom and eight for the walls —considered favorably, but finally discarded because of belief that the many junctures would weaken the walls; and the single caisson plan, adopted and used. The caisson as first made was 492 feet long, 116.24 feet wide and about 59 feet deep. To this was later added an extension giving the dock a total length of 609 feet. The caisson was erected in a pit, which could afterward be connected with the sea so it could be floated out. It was then towed out, partially sunk, moved into position in the foundation pit, which had meantime been excavated by dredges, and brought to final depth, the filling in with concrete and the building up of the masonry not being remarkable except for the caution used in distributing the load so as to secure equal settlement and prevent distortion. Concrete found only partial application in this instance, but as the *Record* says: "It is a material admirably adapted to the requirements of dock construction. It can be made monolithic, and by a suitable combination with light steel members embodied in it, it possesses peculiar resisting qualities required by the reversal of duties to which a dock is subjected in the course of alternate filling and emptying. * * * The presence of steel gives a high tensile resisting capacity and a resulting beam strength, so to speak, that may readily eliminate the possibility of serious settlement cracks which would otherwise appear and produce grave doubts as to stability. This extension of the field of combined concrete and steel construction has not yet received much attention, but it cannot fail to take place."

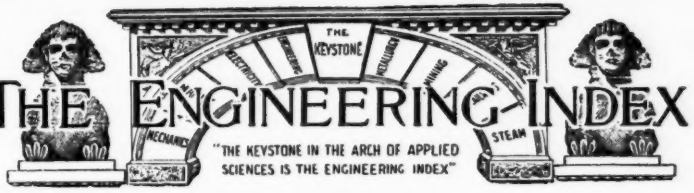
Novel Way of Installing a Shaft.

A SHORT paper by Commander Webster, U. S. N., in the *Journal of the American Society of Naval Engineers,* describes, by photograph almost as much as by text, the novel and interesting method employed in placing the propellor shaft in the United States torpedo boat Shubrick after she was afloat and without placing her in dry dock.

The Shubrick was built at Richmond, Va., at the yards of the Wm. R. Trigg Company, described in Mr. Fawcett's article elsewhere in this issue. As it became apparent, when she was otherwise completed, that long delay would occur before the shaft could be delivered by the contractors, and room on the ways was needed, she was launched without it in October, 1899, and so remained until March, 1900, when the installation of the shaft was undertaken.

The bow of the Shubrick was depressed by admitting about 22 tons of water into a forward compartment. Then a floating derrick having a hull 52 feet in length, 31 feet wide and 6 2-3 feet deep, drawing 2 feet and displacing 92 tons at normal draught, was brought around to her stern; ropes were passed under the hull and hooked to the tackle on the sheer legs, and the stern of the torpedo boat was lifted about 10 feet clear of the water. The angle of inclination of the scow under the load was almost exactly that of the hull of the vessel, rendering the work of placing the shaft comparatively simple. The extra load imposed on the derrick scow, including the partial weight of the torpedo boat and the weight of shafting, men and tackle, was 45 tons. The Shubrick is 175 feet long, and the distance from point of emergence to stern was 62½ feet, or more than one-third of her length.

Careful examination during this suspension showed no undue strain on framing or plating, and the fact that the shaft went into place without difficulty was evidence that there was no deflection.



The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, *in the original language;* and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; and H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. w. Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Pontes et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.

Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.

Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wisconsin, Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.

California Architect. *m.* San Francisco, U. S. A.
Canadian Architect. *m.* Toronto.

Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Socities. *m.* Philadelphia, U. S. A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Journal Western Soc. of Eng. *b-m.* Chicago,
Journal of Worcester Poly. Inst., Worcester, Mass.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Metal Worker. *w.* New York.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U. S. A.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur des Architects. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nature. *w.* Paris.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Proceedings St. Louis R'way Club, *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U. S. A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Arch.

A Massive Foundation Arch. Illustrated description of very heavy 32-ft. brick arches supporting a part of a heavy building on the line of large water mains. 1200 w. Eng Rec—June 23, 1900. No. 34917.

Armory.

The Seventy-fourth Regiment Armory, Buffalo. Illustrated description of a 550 x 250-ft. armory, said to be the largest in the country. Special attention is paid to the details of the iron work, particularly the 227-ft. arch trusses of the drill hall. 2800 w. Eng Rec—June 9, 1900. No. 34662.

Builders' Methods.

Rebuilding the Kansas City Convention Hall. Illustrated description of the methods adopted in erecting with unusual rapidity the 187-ft. arch trusses of this building. 800 w. Eng Rec—June 23, 1900. No. 34916.

Chimneys.

Felling Tall Chimneys. Illustrates an effective and cheap method used in England. 1100 w. Sci Am—June 16, 1900. No. 34829.

The Chimney of the Metropolitan Street Railway Company's Power-House, New York. William Wallace Christie. Illustrated detailed description of the highest chimney in America. 1800 w. R R Gaz—June 8, 1900. No. 34639.

See also Mechanical Engineering, Steam Engineering.

Foundations.

See Arch, above.

Hospital.

Hospital Wall Construction. Illustrated description of special details arranged to prevent any accumulation of dust about the heating coils in wards. 600 w. Eng Rec—June 9, 1900. No. 34661.

Museum.

A Plan for Buildings on the "Kohleninsel" at Munich (Ein Entwurf zur Bebauung der Kohleninsel in München). Description and illustrations of very artistic museum, exposition buildings, etc., which it is proposed to erect on an island in the Isar River at Munich, abstracted from a memoir entitled "Die würdige Ausgestaltung der Kohleninsel und die Jubiläums-Ausstellung des Bayerischen Kunstgewerbevereins. Serial. 3 parts. 2000 w. Deutsche Bauzeitung—April 14, 18, 21, 1900. No. 34700 each B.

Roofs.

Some Comparisons of Graphic Statics Applied to Roofs. Henry Adams. Explanatory article of elementary work in graphic statics. 2000 w. Nat Build—June, 1900. No. 34935 C.

Retort-House Roofs. A. T. Walmisley. Read before the Incor. Gas Inst. A discussion of various types of roofs. Ill. Also general discussion. 8000 w. Gas Wld—June 16, 1900. No. 35016 A.

Roof Trusses.

The Calculation of Roof Trusses and Their Supports in Iron Structures (Die Berechnung der Binder und Ständer Eiserner Wandfachwerk). L. Geusen. A long mathematical article, with diagrams and tables. Serial. 1st part. 2500 w. Zeitschr d Ver Deutscher Ing—May 19, 1900. No. 34713 D.

Stresses.

Secondary Stresses in Framed Structures. Thomas A. Clark. A mathematical study of stresses and their strains. 1200 w. Engs' Year Book, Univ of Minn—1900. No. 35054 E.

The Bending Stresses in Flat Rectangular Concrete Floors. W. Dunn. Explains formulæ given in English books on applied mechanics, and gives a diagram for finding approximate maximum stresses on flat rectangular plates uniformly loaded. 2000 w. Jour Roy Inst of Brit Archts—May 26, 1900. No. 34864 B.

Wood Screws.

Holding Power of Wood Screws. W. M. Macphail and T. T. Irving. Read before the Can. Soc. of Civ. Engs. Tests made to determine the relation between the strength developed and the size of screw in different woods, both parallel to and across the grain. 2200 w. Prac Engr—June 1, 1900. No. 34801 A.

The Holding Power of Screws in Wood. Walter J. Graves. Describes tests and investigations made, giving general conclusions. 3000 w. Trans Assn of Civ Engs of Cornell Univ—1900. No. 35026 D.

HEATING AND VENTILATION.

Central Stations.

Central Heating Stations. Alton D. Adams. Information concerning heating systems for detached buildings, and for

public supply. 2400 w. Munic Engng —June, 1900. No. 34542 C.

Explosions.

Explosions in a Hot-Water Heater. William J. Baldwin. A statement of their cause. 700 w. Eng Rec—June 2, 1900. No. 34541.

Hospitals.

An English System of Hospital Warming and Ventilation. Review of statement of present practice made by T. Wilson Aldwinckle before the Arch. Assn. of London. 800 w. Eng Rec—June 2, 1900. No. 34538.

Hot-Water System.

Hot Water Circulation. Robert W. King. Read before the Toronto Engs' Club. Illustrates and describes points to be met in designing an efficient hot-water heating apparatus. 4200 w. Can Archt—June, 1900. No. 34927 C.

Indirect Hot-Water Heating in a New York Residence. Illustrated description of a very extensive indirect system in which fans are provided for moving the air when the wind conditions are unfavorable. 1800 w. Eng Rec—June 23, 1900. No. 34919.

Schools.

Heating of the Indian School, Genoa, Neb. Illustrated description of a one-pipe steam heating plant for detached buildings. 1000 w. Eng Rec—June 2, 1900. No. 34539.

Some Features of New York School-Houses. Illustrated description of a double stairway in a single well, movable partitions, children's toilet rooms, and other features of buildings erected in 1899. 800 w. Eng Rec—June 16, 1900. No. 34858.

Ventilation and Heating of the Law School Building, University of Pennsylvania. Illustrated description of a system of warming by a heated supply of fresh air and ventilation on the plenum system, with numerous special details of construction. 3300 w. Eng Rec—June 16, 1900. No. 34856.

PLUMBING AND GAS FITTING.

Good Plumbing.

A Model Plumbing Installation. Illustrates and describes the apparatus in an engineering school to illustrate good plumbing practice and afford an opportunity for experiments of various classes. 1000 w. Eng Rec—June 9, 1900. No. 34663.

Power House.

Hydraulic Engineering in Metropolitan Power House. Illustrated description of the water supply and sanitary fittings of the Metropolitan power house in New York City. 1200 w. Met Work—June 30, 1900. Serial. 1st part. No. 34799.

MISCELLANY.

Buildings.

How to Study Buildings. C. H. Blackall. Suggestions for students traveling for the study of architecture, illustrating the process by examples. Ill. 6800 w. Archt Rev—May, 1900. No. 34597 D.

Derrick.

A Tower Derrick for Building Erection. Illustrated description of a special tower for handling material under exceptionally difficult conditions. 700 w. Eng Rec—June 16, 1900. No. 34859.

Fire Prevention.

The Prevention of Loss from Fire by Mutual Insurance. Editorial on a review of the development of mutual factory fire insurance in the United States, published by Edward Atkinson, discussing some of the causes of fires. 1700 w. Eng News—May 31, 1900. No. 34518.

Fire Tests.

Fire Tests with Floors. An illustrated account of an experimental fire test, made in England, with a floor of deal joists, with coke breeze concrete. 1300 w. Fire & Water—June 2, 1900. No. 34560.

Paris Exposition.

Architecture at the Paris Exposition of 1000 (Die Architektur auf der Pariser Weltausstellung des Jahres 1900). Albert Hofmann. A general descriptive and critical article, with illustrations and plans. Serial. 1st part. 2000 w. 1 plate. Deutsche Bauzeitung—May 26, 1900. No. 34702 B.

Terra-Cotta.

The Independence of Burned Clay as a Decorative Building Material. Herman C. Mueller. Read before the Am. Ceramic Soc. Also discussion. Considers its treatment and advantages. 2400 w. Brick—June, 1900. No. 34555.

CIVIL ENGINEERING

BRIDGES.

Arch.

New Double 140-Ft. Span Stone Arch Bridge for the Fitchburg R. R. at Bellows Falls, Vt. Illustrated description of the construction of one of the most notable stone arch railway bridges in America. 1100 w. Eng News—June 21, 1900. No. 34957.

The Bellefield Stone Arch Bridge, Pittsburg. Illustrated description of a masonry arch bridge of 150 ft. span and 85½ ft. width. 1300 w. Eng Rec—June 9, 1900. No. 34657.

See also Architecture, Construction.

Exposition Foot-Bridge.

Foot-Bridge Over the Seine Between the Pont de l'Alma and the Pont de Jena (Passerelle sur la Seine entre le Pont de l'Alma et le Pont d'Jena). Ch. Dantin. A well illustrated description of this steel bridge, of which the main span is a parabolic arch, and its construction and design. 4500 w. 1 plate. Génie Civil—May 26, 1900. No. 34750 D.

Inspection.

Bridge Inspection on the Erie Railroad. A statement of the organization for bridge inspection, the blanks used for the reports, and the directions to the inspectors. 1500 w. Eng Rec—June 2, 1900. No. 34537.

Lift Bridge.

A Rolling Lift Bridge at Cleveland. Illustrates and describes a Scherzer rolling lift bridge, of the single arm type, being built by C. C. C. & I. Ry. to replace an old wooden swing span. 900 w. Ry Age —June 8, 1900. No. 34653.

Plate-Girder.

A 128-Foot Plate-Girder Railroad Bridge. Illustrated description of its details and method of transportation and erection. 2000 w. Eng Rec—June 16, 1900. No. 34852.

Potomac Bridge.

The Prize Designs for the Proposed Memorial Bridge Across the Potomac River at Washington, D. C. Reviews the report submitted by the board appointed to examine the designs. 1500 w. Eng News—June 21, 1900. No. 34961.

Pratt Truss.

New Skunk River Bridge, C. B. & Q. Ry. Illustrated description of a double-track deck structure composed of three main spans of 146-ft. length, of the Pratt type, the trusses being 36 ft. 6 in. deep, bringing the track about 68 ft. above low water. 900 w. Ry & Engng Rev—June 9, 1900. No. 34697.

Steel.

The Proposed Specifications for Steel for Bridges, etc. H. R. Seaman. Considers the manufacturers' specification, criticising various clauses. 700 w. R R Gaz—June 22, 1900. No. 34974.

Swing-Bridges.

Reactions in Swing-Bridge Trusses. Willis Whited. Discusses the pier and abutment reactions in trussed draw bridges of both the center-bearing and rim-bearing types. 4000 w. Pro of Engs' Soc of W Penn—Feb., 1900. No. 34651 D.

The Duluth and Superior Bridge. Illustrated description of the truss and turning details of a very heavy swing span. 2500 w. Eng Rec—June 23, 1900. No. 34913.

The Spuyten Duyvil Swing Bridge; New York Central & Hudson River R. R. Illustrated detailed description. 1100 w. Eng News—June 14, 1900. No. 34885.

Viaduct.

Special Bridge and Viaduct Construction in Western Pennsylvania. Illustrated description of a 1,340-ft. bridge at Fort Perry carrying two tracks, but with one of the trusses proportioned to carry one-half the weight of a third track when a third truss is built alongside. The main 400-ft. span has very heavy details. 2000 w. Eng Rec—June 2, 1900. No. 34533.

Steel Footbridge Over the River Spree, Near Berlin, Germany. Illustrated description of the interesting features of an unusual design. 600 w. Eng News—June 14, 1900. No. 34881.

A Handsome Viaduct Over the Spree. Brief illustrated description of a very ornamental German viaduct. 400 w. Ry Age—June 1, 1900. No. 34617.

CONSTRUCTION.

Arch.

See Architecture, Construction.

See also Civil Engineering, Bridges.

Docks.

The Eastern Minnesota Ore Dock. Dwight E. Woodbridge. Illustrates and describes the largest iron ore shipping dock ever built and the largest piece of timber construction in the world. 1200 w. Ir Age—June 21, 1900. No. 34928.

Dry Dock Construction. A statement of the advantages of concrete-steel construction for dry-docks. 900 w. Eng Rec—June 16, 1900. No. 34847.

Dry Dock with Steel Caisson Foundations at the Port of Toulon, France. Two-page plate and description of a novel application of pneumatic steel caisson foundations. 2800 w. Eng News—June 7, 1900. No. 34687.

Pile Driving.

Hydraulic Pile-Screwing. C. W. Anderson, before the Inst. of Civ. Engs. Illustrating and describing water motors for screwing piles into hard material and giving results of work with these machines. 1700 w. Eng Rec—June 16, 1900. No. 34855.

Roads.

Road Building and Maintenance in France. Harry Fielding Reid. From the Maryland Geological Survey, Vol. III. Gives statistics of cost of construction and

maintenance, describing the systems of inspection, maintenance and construction. 2200 w. Stone—June, 1900. No. 34874 C.

Stresses.

See Architecture and Construction.

Tunnels.

A Description of the Intersection of the Cataract Construction Company's Tunnels at Niagara Falls, N. Y. George F. Simpson. An illustrated detailed description of this work. 6500 w. Trans Assn of Civ Engs of Cornell Univ—1900. No. 35023 D.

Survey and Construction of the Cascade Tunnel by the Great Northern Railway Through the Cascade Range, State of Washington. M. E. Reed. An illustrated account of the work. 2400 w. Engs' Year Book, Univ of Minn—1900. No. 35052 E.

The Construction of the Turchino Tunnel. Illustrated description, from *Genio Civile*, of a 2,190-ft. tunnel driven in an unusual manner, which is explained in detail. 800 w. Eng Rec—June 2, 1900. No. 34536.

The East Boston Tunnel. Illustrated description of the double-track street-railway tunnel now being constructed under Boston Harbor by the Boston Transit Commission. 1000 w. Eng Rec—June 2, 1900. No. 34532.

HYDRAULIC AND WATER SUPPLY.

Austin Dam.

Soundings and Measurements at the Break in the Austin Dam. Thomas U. Taylor. Report of soundings made by the writer on June 9. Ill. 450 w. Eng News—June 21, 1900. No. 34962.

Speculations Suggested by the Austin Dam. W. R. Hutton. Letter discussing the effect of overflow on river bed below dam. 1000 w. Eng Rec—June 9, 1900. No. 34664.

Canals.

Canadian Canals and Trade. Editorial concerning the project for the construction of a deep-water canal from Georgian Bay to Ottawa and Montreal by way of Lake Nipissing and the Ottawa River, and the effect on traffic of the Great Lakes. 1600 w. Engng—June 15, 1900. No. 34989 A.

Methods and Results of Surveys and Borings for Oswego-Mohawk Ship Canal Route. D. J. Howell. Part first describes the methods of work, conditions, etc. 4200 w. Eng News—June 21, 1900. Serial. 1st part. No. 34958.

Croton Aqueduct.

The Preliminary Alinement of the New Croton Aqueduct. E. Sherman Gould. Gives details of some of the preliminary instrumental work connected with the location of the center line of the New Croton Aqueduct. 2200 w. Eng News—May 31, 1900. No. 34516.

Dams.

Investigation of the Distribution of Pressure on the Base of Dams, by Tests Made on an Elastic Model. F. F. Hall. Illustrated description of the apparatus used and method of experimenting, discussing results. 4000 w. Trans Assn of Civ Engs of Cornell Univ—1900. No. 35021 D.

See also Austin Dam, above.

Docks.

See Civil Engineering, Construction.

Drainage.

Run-Off of the Sudbury River Drainage Area, 1875-99, Inclusive. Charles W. Sherman. This watershed is one of the principal sources of the Boston water supply. Tabulated reports for the twenty-five years are given. 700 w. Eng News—May 31, 1900. No. 34520.

Dredges.

Experiences in the Operation and Repair of the Hydraulic Dredges on the Mississippi River. F. B. Maltby. Relates some of the experiences in the operation, the methods, results obtained, and repairs made necessary through wear. 4500 w. Jour Assn of Engng Socs—May, 1900. No. 35041 C.

Dredging.

The Bates Dredge for Calcutta. Illustrated description of a sea-going hydraulic dredge noteworthy for having the ladder for the suction pipe and cutter in a well-way in the center in the forward third of the hull. 2000 w. Eng Rec—June 9, 1900. No. 34660.

Filtration.

Mechanical Filtration. Edmund B. Weston. On the purification of water supplies by the use of sulphate of alumina in connection with the subsidence gravity system of mechanical filtration. Outlines the process, describing in detail and giving illustrations. Also discussion. 11000 w. Jour N. E. Water Wks Assn—June, 1900. No. 34499 E.

The Albany Water Filtration Plant. Allen Hazen. An informal talk at the Syracuse convention. Reviews the history of the supply, describes the plant, its construction and operation. Ill. 11000 w. Jour N. E. Water Wks Assn—June, 1900. No. 34498 E.

Flow.

Flow of Water Over Sharp-Crested Weirs. W. C. Parmley. Mathematical discussion of the manner of solving this problem. 4500 w. Wis Engr—June, 1900. No. 34863 D.

The Flow of Water Over Dams and Spillways. Editorial discussion of the lack of applicability of weir formulas for

estimating the discharge over dams and spillways. 900 w. Eng Rec—June 2, 1900. No. 34530.

The Flow of Water Over Weirs. Gardner S. Williams. Describes methods of computing, investigations made, etc., considering the reliability of formulæ used. 3000 w. Trans Assn of Civ Engs of Cornell Univ—1900. No. 35027 D.

Isthmus Canal.

Sea Level Canal Across the Isthmus of San Blas. William W. Redfield. Presenting the merits of this route, and giving information concerning it. Map. 4800 w. Jour Assn of Engng Socs—May, 1900. No. 35044 C.

The Nicaragua Canal—Hearing of the Commissioners. Editorial discussion of the report of the Commissioners before the Senate Committee. 2200 w. R R Gaz —June 1, 1900. No. 34573.

Laboratory.

Mount Prospect Laboratory. George C. Whipple. Illustrated description of the chemical laboratory, and the biological and chemical analysis of Brooklyn's drinking water. 6800 w. Sci Am Sup—June 30, 1900. No. 35067.

Lowell, Mass.

Lowell, Mass., and Its Water Supply. Extracts from the last annual report showing a flourishing condition from a financial standpoint. Ill. 500 w. Fire & Water—June 16, 1900. No. 34860.

Mains.

New Rising Main, Pittsburg, Pa. Illustrated description of a 48-inch riveted steel force main, 3,930 ft. long, with details of special connection, expansion joint and manholes. 1400 w. Eng Rec—June 9, 1900. No. 34658.

The Disinfection of Water Mains with Chloride of Lime. From the London *Surveyor*. Describes disinfecting the mains at Maidstone. Eng., after an epidemic of typhoid fever. 1000 w. Eng News—June 21, 1900. No. 34963.

New Orleans.

The Water Supply of New Orleans. John M. Ordway. States the conditions to be met and sketches a scheme for the supply of pure water to the city. 4000 w. Jour Assn of Engng Socs—May, 1900. No. 35042 C.

Pumps.

Test of a Twenty-Million-Gallon Pumping Engine. Gives the leading results of tests by R. W. Hunt & Co., of a vertical compound condensing flywheel engine at Omaha. 600 w. Eng Rec—June 16, 1900. No. 34857.

Reclamation.

Land Reclamation in Norfolk. Describes the system adopted, which makes the sea itself the maker of the land. 1500 w. Engng—June 1, 1900. No. 34811 A.

Reservoirs.

Recent Reservoir Construction, Worcester, Mass. Illustrated description of reservoirs with special spillways and aerating details. 700 w. Eng Rec—June 23, 1900. No. 34914.

River Pollution.

Improvement of the Mersey and Irwell Rivers. A review of the work accomplished in 8 years in keeping sewage and manufacturing wastes out of these streams. 900 w. Eng Rec—June 9, 1900. No. 34656.

The Conservation of the Thames. On the progress made in improving the general sanitary condition. 1800 w. Engr, Lond—June 1, 1900. No. 34819 A.

Water Supply.

Notes on the Relation Between the Geology of the Sources of Water Supply and Disease. Marsden Manson. Facts gathered while traveling on the Pacific coast. 2500 w. Jour Assn of Engng Socs—May, 1900. No. 35043 C.

Water-Works.

The Improvement of Spot Pond. Describes the method of cleaning and enlarging a natural pond of 296 acres to form a large distributing reservoir. 3000 w. Eng Rec—June 16, 1900. No. 34853.

The Monroe Suit for Defective Fire Protection. Review of an opinion by the Louisiana Supreme Court, holding a private company responsible for deficient fire protection under both a general franchise and special contracts with individuals, while refusing to hold the city liable under like conditions. 1200 w. Eng Rec—June 2, 1900. No. 34531.

The Mt. Prospect Laboratory of the Brooklyn Water-Works, Greater New York. George C. Whipple. Illustrated description of the building, and of the work carried on. 7200 w. Eng News—June 7, 1900. No. 34688.

The Water-Works of Crisfield, Md. Illustrated description of small works using air lifts for pumping wells. 1000 w. Eng. Rec—June 2, 1900. No. 34535.

Weirs.

See Flow, above.

MATERIALS.

Brick Piers.

Tests of Brick Masonry Piers. E. J. McCaustland. An account of tests made and results obtained. 2200 w. Trans of Assn of Civ Engs of Cornell Univ—1900. No. 35020 D.

Cement.

Cement Tests. A. S. Cooper. On the need of uniformity in testing, with critical remarks on method adopted by the Am. Soc. of Civ. Engs. and suggestions for im-

provements. 1500 w. Wis Engr—June, 1900. No. 34862 D.

The Michigan Alkali Co.'s Plant for Manufacturing Portland Cement from Caustic Soda Waste. B. B. Lathbury. Illustrated description of the interesting features of this plant, which uses lime waste from a caustic soda plant. Also editorial. 5700 w. Eng News—June 7, 1900. No. 34683.

The Proper Manipulation of Tests of Cements; a Symposium. Reviews the results given in the committee report of the Am. Soc. of Civ. Engs. of tests of hydraulic cement. 2500 w. Eng News—June 21, 1900. No. 34960.

Concrete.

Strength of Concrete with Different Per Cent. of Voids Filled. William A. Hawley and B. F. Krahl. Abstract of a graduation thesis. Report of a series of experiments made. 800 w. Eng News—June 7, 1900. No. 34684.

Timber.

A Proposed Method for the Preservation of Timber. F. A. Kummer. Condensed from a paper read before the Am. Soc. of Civ. Engs. Describes experiments made with a view of improving the creosoting process. Explains the reasons for the decay of timber, and considers the steps necessary to prevent it. 3200 w. Eng News—June 7, 1900. No. 34686.

The Strength of Timber, and How to Test It. This paper is based on a lecture delivered by Prof. Hudson Beare. Deals with the methods and modern experiments for the determination of the chief mechanical properties. 3500 w. Builder—June 2, 1900. No. 34800 A.

MUNICIPAL.

Garbage.

See Refuse, below.

Lighting.

Municipal Lighting Plants in Massachusetts. An analysis of the reports of 17 municipal lighting plants, giving costs of service to private consumers and for public lighting. 1100 w. Eng Rec—June 9, 1900. No. 34655.

Pavements.

What Pavements Do for a City. J. W. Howard. Extract from an address before the Board of Trade of Lowell, Mass. Notes some of the benefits of good pavements and their importance. 1800 w. Munic Engng—June, 1900. No. 34543 C.

Economics of Street Paving. S. Whinery. An outline of things to be considered in deciding upon a street pavement, with the investigations that should be made. 7300 w. Trans Assn of Civ Engs of Cornell Univ—1900. No. 35025 D.

Refuse.

The Economical Disposal of Town Refuse. Brierley Denham Healey. Explains the various systems adopted for burning this refuse, and of utilizing the heated gases in such a manner as to make the process economical. Ill. 8300 w. Soc of Engs, Lond—May 7, 1900. No. 34526 D.

The Town's Refuse Problem. Concerning the constituents of refuse and the best means of disposal. 1600 w. Elec Rev, Lond—June 1, 1900. Serial. 1st part. No. 34804 A.

Garbage Reduction at Cleveland, O. Illustrated description of the system and plant. 1400 w. Eng News—May 31, 1900. No. 34517.

Sewage.

Recently Improved Methods of Sewage Disposal. Details of plants inspected and the results. 3300 w. San—June, 1900. No. 34525 D.

The Bacterial Treatment of Sewage. A discussion of this subject, the methods of application, and points of importance. 2800 w. Engr, Lond—May 25, 1900. No. 34604 A.

The Bacterial Treatment of Sewage. Frank Clowes. Discusses these processes and the experiences obtained from experiments, giving illustrations of some species of bacteria found in sewage. 3000 w. Nature—June 7, 1900. No. 34879 A.

Damages Due to Sewage Disposal in New York. A statement, largely quoted from a recent decision of the State court of final resort, outlining the remedies open to a property owner injured by the disposal of sewage from public sewers. 1200 w. Eng Rec—June 16, 1900. No. 34848.

Sewage Disposal at Sheffield, England. Gives the results of investigations with various methods of disposal, and the final recommendations for new works. 2100 w. Eng Rec—June 9, 1900. No. 34659.

The Manchester Sewage Disposal Experiments. Illustrated description of the bacteria beds, septic tank system and Roscoe filters used in 1898 and 1899, and their method of operation. 2600 w. Eng Rec—June 23, 1900. Serial. 1st part. No. 34915.

The Illinois River. A statement of the conflicting projects for its improvement, drawn up by U. S. engineers for navigation purposes alone, and by Chicago engineers to prevent floods due to the discharge from the Chicago drainage canal. 800 w. Eng Rec—June 9, 1900. No. 34654.

The Septic Tank System at Independence. Illustrated description of a number of septic tank and filter plants for different sections of Independence, Mo. 1000 w. Eng Rec—June 16, 1900. No. 34850.

Sewage Disposal.

See also River Pollution, under Hydraulic and Water Supply, above.

Sewerage.

Difficulties Encountered in Building the Storage Well for the Sewerage System of Concord, Massachusetts. Leonard Metcalf. Illustrated account of the essential features of the construction and some of the difficulties, the cost, etc. Discussion. 6000 w. Jour Assn of Engng Socs—May, 1900. No. 35040 C.

Sewers.

An Interesting Sewer Inspection. Describes the condition of an interesting sewer in Columbus, Ohio, after 6 years' service. 600 w. Eng Rec—June 16, 1900. No. 34849.

Cleaning Catch-Basins and Sewers. A. Prescott Folwell. Explains the methods and cost of such work in many American cities. 2500 w. Eng Rec—June 16, 1900. No. 34851.

Sidewalks.

Cement Sidewalks. W. K. Eldridge. Letter discussing reasons for failure of cement walks. 1800 w. Eng Rec—June 2, 1900. No. 34540.

MISCELLANY.

China.

The Coming Engineering Development of the Far East. Wm. Barclay Parsons. An admirable illustrated analysis of the characteristics displayed in native Chinese construction, and of the departments of engineering work in which there will be opening for Caucasian enterprise. 3000 w. The Engineering Magazine—July. No. 34756 B.

Hydrography.

The Survey of the Mouths of the Yukon River, Alaska. G. R. Putnam. An interesting illustrated account of the methods and of the information gained. 4500 w. Eng News—June 7, 1900. No. 34682.

Surveying.

Instructions for Surveying New York State Canals. A review of the rules formulated by the State engineer with the assistance of a board of consulting engineers. 3500 w. Eng Rec—June 16, 1900. No. 34854.

The Work of the United States Coast and Geodetic Survey. From the 67th Annual Report of the Survey, giving a brief historical summary of the work. 800 w. Eng News—June 7, 1900. No. 34685.

Government Surveys on the Ohio River. Describes methods employed in hydrographic surveys for river improvements costing $20,000,000. 2100 w. Eng Rec—June 30, 1900. No. 35104.

ELECTRICAL ENGINEERING

COMMUNICATION.

Address.

Mr. A. W. Heaviside's Presidential Address to the Newcastle-on-Tyne Local Section of the Institution of Electrical Engineers. Abstract. Reviews the history of the telegraph, telephone and other electrical industries and their position in Newcastle. 4800 w. Elect'n, Lond—June 8, 1900. No. 34898 A.

Cables.

A Practical Transmitter Using the Sine Wave for Cable Telegraphy; and Measurements with Alternating Currents Upon an Atlantic Cable. A. C. Crehore and G. O. Squier. Extracts from a paper read before the Am. Inst. of Elec. Engs.; also editorial. 5300 w. Elec Rev, N. Y—June 20, 1900. No. 34981.

Practical Examples of Simultaneous Testing, as Applied to Fault Localization in Submarine Cables. C. W. Schaefer. Describes applications of theoretic methods to actual work. 2700 w. Elect'n, Lond—June 8, 1900. No. 34899 A.

The First Submarine Cable. W. F. Bradshaw, Jr. An account of the cable laid across the Ohio River by John Boyd Sleeth, Ill. 800 w. Sci Am—June 23, 1900. No. 34954.

Electrical Waves.

Wave Transmission Over Non-Uniform Cables and Long Distance Air Lines. M. I. Pupin. Describes experimental investigation of a method of constructing cables and long-distance air-lines, particularly for long-distance telephony and telegraphy. 14000 w. Trans Am Inst of Elec Engs—April, 1900. No. 35050 D.

Switzerland.

Telegraphy and Telephony in Switzerland in 1899 (Telegraphen und Fernsprechwesen in der Schweiz im Jahre 1899). A full abstract of the official government report, with tables. Serial. 2 parts. 5000 w. Elektrotech Zeitschr—May 10, 17, 1900. No. 34726 each B.

Telegraphs.

Electro-Magnetic Mechanism with Special Reference to Telegraphic Work. R. A. Fessenden. Concerning the designing of electromagnetic mechanism; discussion of electrical units, equations of energy, etc. 3300 w. Jour Fr Inst—June, 1900. Serial. 1st part. No. 34646 D.

Imperial Telegraphic Communication. Sir Edward A. Sassoon. Reviews the history of cable communication between England and her colonies, and presents the present situation. Also discussion. 12500 w. Jour Soc of Arts—June 15, 1900. No. 34968 A.

Telegraphon.

The Poulsen Telegraphon or Magneto-Telephonograph (Rundschau). A description of this apparatus, in which a steel wire or ribbon travels before the magnet of a telephone receiver and has its permanent magnetism altered, so that when the wire is moved past another telephone the sounds will be reproduced. 1000 w. Elektrotech Zeitschr—May 17, 1900. No. 34727 B.

Telephones.

Telephone Development. Ed. L. Barber. Read before the Ind. Tel. Assn. A review of progress. 1400 w. W Elec'n—June 16, 1900. No. 34938.

Telephony.

Dr. Pupin's Improvements in Long-Distance Telephony. Herbert T. Wade. Illustrated description of investigations made, and their application to long-distance telephony. 2600 w. Sci Am—June 2, 1900. No. 34507.

The Possibility of Trans-Atlantic Telephony. An account of an interview with Dr. M. I. Pupin on his new system of cable construction. 800 w. Elec Rev, N. Y.—June 6, 1900. No. 34630.

Toll-Lines.

Toll-Line Traffic. J. B. Ware. Read at Cleveland meeting of the Ind. Tel. Assn. Considers toll rates and the division of the fees. 2500 w. W Elec'n—June 16 1900. No. 34937.

DISTRIBUTION.

Circuits.

On the Spark Due to the Break of an Electric Circuit. K. R. Johnson. Imagines an ideal circuit and deduces the true expression of the extra current of the break. 1000 w. Elect'n, Lond—June 15, 1900. No. 35004 A.

Short-Circuit Key.

Rymer-Jones Short Circuit Key. Illustrated description of a new form of short-circuit key. 800 w. Elec Rev, Lond—June 15, 1900. No. 35009 A.

Temperature.

On the Heating of Underground Electric Conductors (Ueber die Erwärmung Unterirdischer Elektrischer Leitungen). K. Wilkens. Theoretical considerations, and results of tests made on underground cables under normal working conditions in Berlin, with curves and tables. 2500 w. Elektrotech Zeitschr—May 24, 1900. No. 34733 B.

Three-Phase.

Mutual Inductance of Three Phase Circuits. Aug. J. Bowie, Jr. Discussing disturbances that arise and the means of overcoming them. Ill. 5300 w. Elec Wld & Engr—June 23, 1900. No. 34944.

Wire Protection.

The Protection of Insulated Wires. Frederick Bathurst. Critical review of articles by Sydney F. Walker. 1600 w. Elec Rev, Lond—May 25, 1900. No. 34615 A.

Wiring.

Notes on Conduit Wiring. H. H. Norris. Describes present practice and methods. 1200 w. Sib Jour of Engng—June, 1900. No. 35035 C.

ELECTRO-CHEMISTRY.

Advancement.

Advancement of Electrical Chemistry. F. Mollwo Perkin. Deals with electrolytic processes for obtaining the non-metallic elements and for the preparation of inorganic and organic compounds. 2600 w. Nature—June 7, 1900. No. 34880 A.

Errors.

Electro-chemistry. Wilder D. Bancroft. The importance of the study, showing the sources of error that may occur in carrying out any electrolytic process and the effect of slight variations. 3000 w. Sib Jour of Engng—June, 1900. No. 35037 C.

Hypochlorite.

The Electrolytic Production of Solutions of Hypochlorite for Bleaching and Disinfecting Purposes. John B. C. Kershaw. Describes electrolyzers for the production of hypochlorite now in use and the comparative costs. Ill. 2800 w. Elect'n, Lond—June 15, 1900. No. 35006 A.

Volta Effect.

The Volta Contact Force. On the deductions of Prof. Oliver Lodge, and the opposing opinions. 2500 w. Engng—June 1, 1900. No. 34812 A.

ELECTRO-PHYSICS.

Electrostatics.

Some Practical Features of the Electrostatic Field. Harris J. Ryan. Discusses the chief characteristics of the field, illustrating and describing phenomena and experiments, and showing the lines along which progress is being made toward rational insulation design. 6000 w. Sib Jour of Engng—June, 1900. No. 35039 C.

Interrupter.

A Current Interrupter (Stromunterbrecher). E. Grimsehl. An illustrated

description of an interrupter consisting of a vibrating tongue, set in motion by compressed air, which makes and breaks contact with mercury. 700 w. Elektrotech Zeitschr—June 14, 1900. No. 34742 B.

A New Type of Mercury Interrupter. Eugene W. Caldwell. Illustrated description. 700 w. Elec Rev, N. Y.—June 20, 1900. No. 34980.

The Action of the Wehnelt Interrupter on Alternating Currents. George T. Hanchett. An explanation of effects observed while experimenting. 1300 w. Elec Wld & Engr—June 16, 1900. No. 34843.

GENERATING STATIONS.

Alternating Currents.

Alternating-Current Generators. H. G. Reist. Read at the Chicago convention of the Nat. Elec. Lgt. Assn. Traces the improvements made in alternating-current generators, describing the latest machines and their operation. Ill. 4000 w. Elec Rev, N. Y.—May 23, 1900. No. 34509.

Central Stations.

Central Stations in the South. W. S. Key. Illustrates and describes the Montgomery Light & Power Company's Central Station in part 1st. 1700 w. Elec Wld & Engr—June 9, 1900. Serial. 1st part. No. 34670.

Copenhagen.

The Vesterbro Municipal Electric Works at Copenhagen (Das Städtische Elektricitätswerk Vesterbro in Kopenhagen). C. G. Hoest. An illustrated description, partly abstracted from the Danish journal, *Ingeniören*, of this central station, which has Siemens & Halske dynamos and a large accumulator plant. 2500 w. Elektrotech Zeitschr—May 10, 1900. No. 34725 B.

Cut-Out.

Heavy Current Cut-Out Switch for Electric Railways and Power Plants (Starkstromausschalter für Elektrische Bahnen und Kraftübertragungen). An illustrated description of an automatic cut-out made by the "Helios" company. 500 w. Zeitschr f Klein u Strassenbahnen—May 1, 1900. No. 34705 C.

Dynamos.

Rotary and Direct Current Generators of the Lahmeyer Electrical Company at the Paris Exposition (Die Elektricität auf der Pariser Weltausstellung. Drehstrom und Gleichstromgeneratoren der Elektricitats-A.-G. vorm. W. Lahmeyer & Co., Frankfurt a. M.). An illustrated description of a 1000 k. w. rotary current generator and a 350 k. w. direct current generator. 500 w. Elektrotech Zeitschr—May 10, 1900. No. 34724 B.

3000 Kilowatt Rotary Current Dynamo of the Allgemeine Elektricitäts-Gesellschaft at the Paris Exposition (Die Elektricität auf der Pariser Weltausstellung. Drehstrom-Maschine von 3000 K W der Allgemeiner Elektricitäts-Gesellschaft). A brief illustrated description of this huge machine. 300 w. Elektrotech Zeitschr—May 17, 1900. No. 34728 B.

Economics.

Operating Economics in Central-Station Practice. W. L. Abbott. Read at Chicago meeting of the Nat. Elec. Lgt. Assn. Considers details of central-station operation and methods of reducing expenses. 4000 w. Elec Rev, N. Y.—May 30, 1900. No. 34616.

Electric Power.

The Cost of Electric Power Production. Philip Dawson. Considers what connection exists between the first cost of a plant and that at which power can be produced. 1400 w. Engng—June 1, 1900. Serial. 1st part. No. 34808 A.

Engine.

2500 H. P. Triple Expansion Engine and Direct-Connected Alternator at the Paris Exposition. Illustrated description of the general details of the engine and alternator installed at the Paris Exposition to provide current for lighting the buildings on the Champ de Mars. 1800 w. Eng News—June 21, 1900. No. 34959.

Isolated Plant.

Wakefield Asylum Electrical Installation. An installation embracing the lighting, heating and ventilating, and the electric driving of the machinery in the workshops and laundry is illustrated and described. 1800 w. Elec Rev, Lond—June 15, 1900. No. 35008 A.

Polyphase Motors.

The Design and Testing of Rotary Current Motors with the Aid of the Polyphase Motor Diagram (Ueber Entwurf und Prüfung von Drehstrommotoren mit Hülfe des Diagramms der Mehrphasen-Motors). Dr. M. Breslauer. A paper before the Elektrotechnischer Verein, giving the theory of polyphase motors and confirmatory tests, with diagrams, tables and curves. 6000 w. Elektrotech Zeitschr—June 7, 1900. No. 34739 B.

Power Plants.

The La Bella Power Plant, Goldfield, Colo. Illustrated description of a 3,600-H. P. plant built to supply electricity within a radius of 6 miles, compressed air within a radius of 2 miles, and water for ore washers near by. A number of interesting features concerning the distribution of air and the method of charging for electric current are explained. 2800 w. Eng Rec—June 2, 1900. No. 34534.

Pike's Peak Company's Power Plant.

J. W. Dickerson. Illustrated description of construction, pipe line, and equipment. 2400 w. Mod Mach—June, 1900. No. 34553.

Rotary Converters

A New Synchronizing Device for Rotary Converters. F. W. Springer. Illustrated description of the device and its operation. 800 w. Elec Wld & Engr—June 23, 1900. No. 34945.

Starting a Rotary Converter by Means of Direct Current Transmitted Over the Alternating Line. Frederick Bedell. An outline for a laboratory experiment. 300 w. Ill. Sib Jour of Engng—June, 1900. No. 35032 C.

Single Phase Motors.

The Resolution of the Oscillating Field of a Single Phase Motor into Rotary Fields (Ueber die Zerlegung des Oscillirenden Feldes des Einphasenmotors in Drehfelder). F. Eichberg. An article giving the theory, with confirmatory experiments on single phase motors. Diagrams and curves. 2000 w. Elektrotech Zeitschr—June 14, 1900. No. 34741 B.

Storage Battery.

The Storage Battery of the Sage Chapel Organ of Cornell University. H. H. Norris. States the problem to be solved and the troubles met. Ill. 1000 w. Sib Jour of Engng—June, 1900. No. 35038 C.

Traction Power Plant.

Notes on American Corliss Engines for Electric Traction. Charles Day. A record of observations made during a visit of the writer to the United States for the purpose of studying the practice in regard to engines for electric traction. Ill. 1500 w. Engr, Lond—May 25, 1900. Serial. 1st part. No. 34605 A.

Engines for the Berlin Tramways. Illustrates and describes triple-expansion engines of the marine type, each group having one high, one intermediate, and two low pressure cylinders, arranged as twin vertical tandems coupled at 180 deg. with two fly-wheels. 1600 w. Engr, Lond—May 25, 1900. No. 34609 A.

Test of the Power Plant of the Buffalo Street Railway. R. C. Carpenter and H. J. Ryan. An outline of the test, explanation of its object, with summary of results and general information. 3800 w. Sib Jour of Engng—June, 1900. No. 35029 C.

Transformers.

Current-Rushes into Transformers. R. C. Clinker. An explanation of the rush of current that often takes place through the primary winding at the instant of switching a transformer on to a live circuit. 800 w. Elect'n, Lond—June 15, 1900. No. 35005 A.

Eddy Current Losses in Transformers. Fitzhugh Townsend. Describes experiments made at Columbia University. 1800 w. Trans Am Inst of Elec Engs—April, 1900. No. 35049 D.

Tri-Phase.

The Central Station of the "Tri-Phase" Company at Asinères, Seine (Usine Electrique de la Compagnie "Le Triphasé" à Asnières, Seine). A very completely illustrated description of this large central station, which will furnish tri-phase currents to Paris. 4200 w. 4 plates. Génie Civil—June 9, 1900. No. 34754 D.

Wind Power.

Wind Power for Electrical Purposes. Roy E. Thompson. Describes the two general methods by which wind power may be applied to the generation of electrical energy. 1400 w. Engs' Year Book, Univ of Minn—1900. No. 35053 E.

HEATING AND WELDING.

Cast Weld Joints.

Cast Weld and Surface Contact Bonds. W. E. Harrington. Illustrated account of tests and results. 2000 w. Jour Fr Inst—June, 1900. No. 34644 D.

LIGHTING.

Arc Lamps.

Arc Lighting. Reviews the improvements made. 1000 w. Elec Rev, N. Y.—June 20, 1900. No. 34979.

On the Intrinsic Brilliancy of the Crater of the Arc. J. E. Pateval. An illustrated account of investigations. 2000 w. Elec Eng, Lond—June 8, 1900. No. 34934 A.

Public Arc Lighting in St. Martin's Parish, London. Illustrates and describes details of the work. 2500 w. Elect'n, Lond—June 1, 1900. No. 34803 A.

Carlisle, Eng.

Carlisle Electric Lighting. Charles D. Burnet. Read before a meeting of the Inc. Assn. of Munic. and Co. Engrs. Illustrates and describes the system, buildings, plant, etc. 2200 w. Elec Eng, Lond—June 8, 1900. No. 34933 A.

Lamp Cut-Out

Incandescent Lamp with Automatic Cut-Out (Glühlampe mit Selbstthätiger Stromunterbrechung). An illustrated description of an apparatus to be attached to an incandescent lamp, which will cut off the current automatically after the lamp has burned a fixed number of hours. 800 w. Elektrotech Rundschau—May 1, 1900. No. 34708 B.

Lamps.

High Efficiency Lamps for Isolated Installation. James Whitcher. Discusses the private supply of electric lighting through a battery of accumulators. 3000 w. Elec Rev, Lond—June 1, 1900. No. 34805 A.

Rating.

The Rating of Electric Lighting. Editorial discussion, and outline of the principles upon which the assessments are now made. 1500 w. Engng—June 8, 1900. No. 34904 A.

MEASUREMENT.

Dynamometer.

A New Transmission Dynamometer. W. Elwell Goldsborough. Illustrated description of the instrument and method of using it. 1800 w. Trans Am Inst of Elec Engs—April, 1900. No. 35047 D.

Electrometer.

The Electrometer in Theory and Practice. J. Warren. A study of the principles underlying its action. 2000 w. Elec, Lond—June 1, 1900. Serial. 1st part. No. 34802 A.

Faradmeter.

A Faradmeter. M. I. Pupin. Illustrated description; also discussion. 2500 w. Trans Am Inst of Elec Engs—April, 1900. No. 35045 D.

Instruments.

Electrical Measurement of Work and Energy. G. L. Addenbrooke. A clear and concise presentation of the principles, methods, and apparatus of electrical measurement, and of their importance in the study of mechanical economy. 4500 w. The Engineering Magazine—July, 1900. No. 34763 B.

Measuring Instruments of Precision for Alternating Currents of the Allgemeine Elektricitäts-Gesellschaft (Präcisionsinstrument für Wechselstrom der Allgemeinen Elektricitäts-Gesellschaft). Dr. G. Benischke. An address before the Elektrotechnische Verein, describing volt, ampère and watt meters, with illustrations; and the discussion ensuing. 4000 w. Elektrotech Zeitschr—May 17, 1900. No. 34731 B.

Meters.

Meters for Showing Conditions at Distant Points (Fernstromzeiger). Dr. Carl Michalke and Dr. O. Martienssen. An article describing a method by which, with the use of suitable connections, only one wire between two stations will enable the current consumption of each to be observed at the other. Diagrams. 1500 w. Elektrotech Zeitschr—June 7, 1900. No. 34738 B.

A Frictionless Motor Meter. S. Evershed. Describes an attempt to remove some of the defects of this particular class of meter, and the outcome. Ill. 8800 w. Brit Inst of Elec Engs—May 10, 1900. No. 34527 D.

Resistance.

A Percentage Bridge. Herschel C. Parker. Describes a method devised by the writer, useful in electrical laboratories. 900 w. Trans Am Inst of Elec Engs—April, 1900. No. 35048 D.

Testing.

Factory Testing of Electrical Apparatus. Arthur H. Ford. Describes methods of testing various kinds of apparatus. 4300 w. Wis Engr—June, 1900. No. 34861 D.

Volt-Hour Meter.

The Volt-Hour Meter of O'Keenan (Der Volt-Stunden-Zähler von O'Keenan). From a paper before the Société Internationale des Electriciens, at Paris, describing this meter and various uses to which it may be applied, with illustrations. 1200 w. Elektrotech Zeitschr—May 31, 1900. No. 34736 B.

POWER APPLICATIONS.

Accumulators.

See Mechanical Engineering, Automobilism.

Calender Driving.

A 50 Horse-Power Electromotor for Directly Driving a Calender Press (50 P S Elektromotor zum Direkten Antrieb eines Kalanders). K. Schindler. Illustrated description of a direct current motor for driving a 12-roll calender at highly variable speeds, with the controlling apparatus. 600 w. Elektrotech Zeitschr—May 17, 1900. No. 34729 B.

Electric Driving

Some Considerations Concerning Electric Driving. H. A. Mavor. Read before the Glasgow section of the Inst. of Elec. Engs. The probability of a large demand for motors and how the manufacturers are to meet it, the kinds of motors desired, etc. 2400 w. Elect'n, Lond—June 15, 1900. No. 35007 A.

Mining Machinery.

Electrical Coal-Mining Machines. Illustrates and describes the working of this type of coal-cutting machines. 1100 w. Sci Am—June 23, 1900. No. 34955.

Electrical Coal Mining Machinery. R. B. Blakeslee. Discusses mechanical engineering problems in the production of bituminous coal, including also problems of anthracite mining and coal cutting. 1700 w. Sib Jour of Engng—June, 1900. No. 35036 C.

Running Collieries Entirely by Electricity from One Center. Sydney F. Walker. Abstract of paper read before the Brit. Soc. of Min. Students. On economy possible by the use of the electric motor. 3000 w. Ir & Coal Trds Rev—May 25, 1900. No. 34611 A.

Swing-Bridges.

Working Swing-Bridges by Electricity. Describes various examples in the United States, where electrically operated machinery has been applied to these bridges.

Ill. 4700 w. Engr, Lond—June 8, 1900. No. 34909 A.

TRANSMISSION.

Snoqualmie Falls.

Snoqualmie Falls Power Transmission. Charles H. Baker. History of the enterprise, with an illustrated detailed description of the plant. 8000 w. Trans of Assn of Civ Engs of Cornell Univ—1900. No. 35019 D.

MISCELLANY.

Becquerel Rays.

Sources and Properties of Becquerel Rays. G. H. Bryan. A general account of a few of the more striking phenomena, including some of the recent developments. 4000 w. Nature—June 14, 1900. No. 34967 A.

Brushes.

The Best Proportions for Brushes with Collector Rings and Commutators (Die Günstigste Dimensionirung der Stromabuehmer bei Schleifringen und Kollektoren). G. Dettmar. A record of a very complete series of experiments on the contact resistance, pressure, dimensions, etc., of copper and carbon brushes, with curves and tables. 4000 w. Elektrotech Zeitschr—May 31, 1900. No. 34734 B.

Cable Factory.

The New Factory Buildings of the Siemens-Halske Company, near Berlin (Die Fabrikneubauten der Siemens & Halske A.-G. am Nonnendamm). C. Dihlmann. A well illustrated description of the new cable factory and brass foundry of the Siemens-Halske Co., on a large tract of land on the Spree. 3000 w. Elektrotech Zeitschr—June 14, 1900. No. 34740 B.

Experts.

Experts and Expert Evidence. J. E. Hindon Hyde. A discussion of the qualities a competent expert should possess. 5500 w. Trans Am Inst of Elec Engs—April, 1900. No. 35046 D.

Gutta-Percha.

The Future Supply of Gutta-Percha. Editorial on the increasing rise in the price of this product and its cause. 2800 w. Engng—June 8, 1900. No. 34903 A.

Lightning.

Destruction of Life and Property by Lightning. M. F. O'Reilly. Discusses the effect of lightning stroke and electric shock, giving statistics concerning the destruction of life and property and general information. 4500 w. Engng—June 15, 1900. No. 34985 A.

Paris Exhibition.

Electrical Engineering at the Paris Exhibition. Part first begins a general review of continental work as compared with English. 2500 w. Engr, Lond—June 15, 1900. Serial. 1st part. No. 34997 A.

Resistance.

Electrical Resistance of Thin Films Deposited by Cathode Discharge. A. C. Longden. A report of investigations. 1000 w. Am Jour of Sci—June, 1900. No. 34528 D.

Varying Voltage.

Dividing the Electromotive Force of Direct Current Dynamos by Means of Inductive Resistances (Spannungstheilung an Gleichstrommaschinen mittels Drosselspulen). Prof. A. Sengel. A mathematical treatment of methods of determining the difference in voltage in a divided circuit of a direct current machine; with results of tests and tables. Serial. 2 parts. 4000 w. Elektrotech Zeitschr—May 17, 24, 1900. No. 34730 each B.

X-Rays.

The Production of the X-Rays by a Battery Current. John Trowbridge. A successful new method of generating these rays and the advantage. 1200 w. Am Jour of Sci—June, 1900. No. 34529 D.

GAS ENGINEERING

Accounting.

Uniform Accounting for Gas and Electric Lighting Companies. James Blake Cahoon. Abstract of a paper read at Chicago meeting of the Nat. Elec. Lgt. Assn., and Editorial on "Uniform Accounting a Prerequisite to National Municipal Statistics." 3000 w. Eng News—June 14, 1900. No. 34884.

Acetylene.

See also Mechanical Engineering, Automobilism.

Some More Enemies of Acetylene. Further discussion of generators and the use of acetylene. 3200 w. Engr, Lond—June 1, 1900. No. 34818 A.

The Manufacture of Alcohol from Acetylene. A review of some of the methods, and the opinions concerning them. Ill. 2000 w. Eng News—May 31, 1900. No. 34519.

Address.

Inaugural Address before the Incorporated Gas Institute, England. E. Her-

bert Stevenson. Discusses the coal famine and the suggested amalgamation of the Institution of Gas Engineers and the Gas Institute. 5500 w. Gas Wld—June 16, 1900. No. 35013 A.

Analysis.

Determination of Benzene and Ethylene on Coal Gas. F. Haber. Abstract translation from the *Journal für Gasbeleuchtung*. Describes the method and manner of carrying out the researches. 2000 w. Jour Gas Lgt—May 29, 1900. No. 34692 A.

Candle Power.

Candle Power: Its Present Relation to the Gas Industry. John R. Lynn. Read before the Western Gas Assn. Also discussion. Considers the various uses of gas and the units of measurement in use, and the measuring of the term "candle power." 7700 w. Am Gas Lgt Jour—June 11, 1900. No. 34672.

Compressors.

Gas Compressors Actuated by Water Under Pressure. From *Revue Industrielle*. Illustrated description of the Keith gas compressor. 1300 w. Sci Am Sup—June 9, 1900. No. 34679.

Condensation.

Temperatures in Condensation. W. H. Barthold. Read before the Western Gas Assn. Also discussion. An account of experience at Grand Rapids, Mich. 5300 w. Pro Age—June 1, 1900. No. 34561.

Electrical Supply.

Electrical Supply by Gas Companies. Alton D. Adams. Discussing the advantages due to the development of the gas-engine. 1600 w. Sci Am—June 16, 1900. No. 34828.

Expert Evidence.

Some Disputed Points Among Gas and Water Experts. John Wilkinson. Read before the Incor. Gas Inst. Discusses the policy of experts when giving evidence. Also general discussion. 5000 w. Gas Wld—June 16, 1900. No. 35017 A.

Gas.

The New Gas. W. H. Y. Webber. Read before the Incorp. Gas Inst. Reviews the recent changes in gas manufacture and the uses to which gas is applied, and the development of the idea of utilizing the heating rather than the illuminating power, and so introducing incandescent gas, now so largely used. 9000 w. Gas Wld—June 16, 1900. No. 35015 A.

Gasholders.

The Guide-Framing of Gasholders. Abstract translation of a paper by Herr Hacker, of Berlin. Considers the uncertainty as to the distribution of the pressure of a wind on the ordinary guide-framing; three independent columns for guiding a gasholder; calculation of the ring 'round the crown, and of the forces transmitted to the columns; and the strain of the cups. Ill. 2700 w. Jour Gas Lgt—June 5, 1900. No. 34834 A.

Gas Plant.

The Plant of the Faribault Consolidated Gas and Electric Company. Oliver Field Allen. Illustrated description of a reconstructed plant. 3000 w. Engs' Year Book, Univ of Minn—1900. No. 35051 E.

Gas Works.

Monthly Technical Report of Operations in Coal Gas Works. W. E. Steinwedell. Read before the Western Gas Assn. Also discussion. Gives a form and suggestions. 4500 w. Am Gas Lgt Jour—June 11, 1900. No. 34671.

Hygiene.

The Hygienic Effect of the Use of Gas. Thomas D. Miller. Read before the Western Gas Assn. An account of investigations made and conclusions reached; also reporting investigations of others. Discussion. 4000 w. Pro Age—June 15, 1900. No. 34844.

Isolated Plants.

Gas-Plants in Large Buildings. Alton D. Adams. Suggestions as to the saving that could be effected by gas-engine and producer plants. 2000 w. Am Archt—June 23, 1900. No. 34941.

Mains.

The Systematic Location of Gas Mains and Other Pipes in the Streets as Opposed to the Popular Idea of a Subway. Donald McDonald. Read before the Western Gas Assn. Also discussion. Points out the objections to subways and outlines a plan considered less objectionable. Ill. 5400 w. Am Gas Lgt Jour—June 11, 1900. No. 34673.

Management.

Inaugural Address before the Association of German Gas and Water Engineers. W. von Oechelhaeuser. Deals principally with the social and moral obligations to workmen, the hygienic conditions, methods of work, etc. 6000 w. Jour Gas Lgt—June 19, 1900. No. 35082 A.

Manufacture.

Improvement in Gas Manufacture. Describes the process patented by John Coyne. of Pittsburg, whereby he asserts that 50,000 cubic feet of gas is secured from a ton of coal. Ill. 1400 w. Am Mfr & Ir Wld—June 14, 1900. No. 34877.

Naphthalene.

Naphthalene from Retort to Point of Deposition. William Young. Shows the important part the crystalline condition of the naphthalene plays in producing troubles, and considers the remedies.

Discussion. 9800 w. Gas Wld—June 16, 1900. No. 35018 A.

Paris Exhibition.

The Gas Pavilion. Description of the building and its arrangement, and of the lighting of the exhibition, especially the lighting of the parks of the Champ de Mars by the Paris Gas Co. 3200 w. Jour Gas Lgt—May 22, 1900. No. 34613 A.

Rates.

Public Control of Rates. George McLean. Read before the Western Gas Assn. Also discussion. Considers it unjust and inexpedient on the part of public service corporations to oppose the principle of public control. 8000 w. Pro Age—June 1, 1900. No. 34562.

Retorts.

Automatic Stoking and Inclined Retorts. William R. Chester. Read at meeting of Incor. Gas Inst. The two successful systems of automatic stoking are considered and the successful development of inclined retorts. Also general discussion. Ill. 6500 w. Gas Wld—June 16, 1900. No. 35014 A.

Roofs.

See Architecture, Construction.

Technical Report.

Monthly Technical Report of Operation in Coal-Gas Works. W. E. Steinwedell. Read before the Western Gas Assn. Suggestions of system of recording operations and converting the data into proper form for reference. With discussion. 3500 w. Pro Age—June 1, 1900. No. 34563.

Temperatures.

Acetylene and Other Flame Temperatures. Edward L. Nichols. Read at meeting of the Am. Physical Soc. Description of apparatus used and observations. 5500 w. Pro Age—June 1, 1900. No. 34564.

MARINE AND NAVAL ENGINEERING

Battleship.

The Japanese Battleship "Asahi." Drawings and full description of the largest battleship afloat. 3500 w. Engng—May 25, 1900. Serial. 1st part. No. 34598 A.

United States Battleship "Georgia" and Class. Illustrated description. 1300 w. Sci Am—June 9, 1900. No. 34677.

Bilge Keels.

The Action of Bilge Keels. G. H. Bryan. Read before the Inst. of Nav. Archts. A theoretical discussion of the principles underlying the use of the bilge keels, showing that their efficacy in extinguishing roller motion is greater than would be directly inferred from experiments. 6500 w. Engng—June 1, 1900. No. 34813 A.

Cable Cutting.

Cable Cutting Operations of U. S. S. "St. Louis" during the Spanish War. Caspar F. Goodrich. An illustrated account of the work. 3400 w. Marine Engng—June, 1900. No. 34635 C.

Cable Ship.

The First German Cable Steamer, "von Podbielski" (Der Erste Deutsche Kabeldampfer "von Podbielski"). Joh. Schütte. An illustrated description of this new cable laying steamer and her engines. 1800 w. Zeitschr d Ver Deutscher Ing—June 9, 1900. No. 34722 D.

Commerce Destroyer.

The French Commerce Destroyer, "Guichen." Gives details of the American vessels of this class, and describes this vessel and the official trials. Ill. 1500 w. Engr, Lond—June 15, 1900. No. 34995 A.

Cruisers.

Contract Trial of the United States Protected Cruiser "Albany." Harold P. Norton and H. G. Gillmor. Illustrated detailed description of the vessel, with report of trials. 8400 w. Jour Am Soc of Nav Engs—May, 1900. No. 34647 H.

Protected Cruisers of the "Denver" Class for the U. S. Navy. Illustrated detailed description of these vessels and their equipment. 1800 w. Marine Engng—June, 1900. No. 34636 C.

Two Notable High-Speed Foreign Cruisers. Illustrates two of the latest high-speed cruisers built in European yards—the "Askold" and the "Chateaurenault." 1000 w. Sci Am—June 30, 1900. No. 35068.

Deutschland.

The German Express Steamer "Deutschland" (Der Deutsche Schnelldampfer "Deutschland"). An illustrated general description of this great steamer, of 23,000 tons displacement, 684 feet long and of 23 knots speed. 1300 w. Glaser's Annalen—May 15, 1900. No. 34744 D.

Dredge.

Self-Propelling Hydraulic Dredge for the Mississippi River. Two-page plate and description of a steel-hulled vessel fitted with side wheels, to be called the "Iota." Describes the tests to be made, as given in the specifications. 2800 w. Eng News—May 31, 1900. No. 34515.

Ferry Boat.

New East River Ferry Boat. An illus-

trated description of the "John Englis," recently launched. 1400 w. Naut Gaz—June 21, 1900. No. 34940.

German Exhibit.

Marine and Light House Exhibits at Paris (Die Weltausstellung in Paris. 1900. Schiffahrt und Kütsenbeleuchtung). A. Rudolph. An illustrated account of the German merchant marine exhibit at the Paris Exposition. Serial. 1st part. 1800 w. Zeitschr d Ver Deutscher Ing—June 9, 1900. No. 34721 D.

Ice Breaker.

The Ice Breaking Pilot Steamer "Haidamak" (Der Eisbrecher, Bergungs- und Lotsendampfer "Haidamak"). A very well illustrated description of the hull, engines, etc., of this Russian pilot boat, 187 feet in length, built at Kiel. 800 w. 1 plate. Zeitschr d Ver Deutscher Ingenieure—May 12, 1900. No. 34709 D.

Large Steamers.

List of German, English and American Merchant Steamers of over 10,000 Tons (Rundschau. Abmessungen der Dampfer der Deutschen, Englischen und Amerikanischen Handelsmarine). A table giving the principal dimensions of 19 German, 9 English and 3 American merchant steamships of over 10,000 tons. 500 w. Zeitschr d Ver Deutscher Ing—June 2, 1900. No. 34720 D.

Liners.

Mammoth Transatlantic Liners. A description of the "Ivernia" and "Saxonia," just added to the Cunard fleet. 2000 w. Naut Gaz—June 7, 1900. No. 34631.

Propeller Shafting.

A Novel Method of Installing Propeller Shafting. Harrie Webster. Describes the placing of the propeller shafting of the torpedo boat "Shubrick," with success and slight comparative cost, after the vessel was launched. 700 w. Jour Am Soc of Nav Engs—May, 1900. No. 34649 H.

Propellers.

How to Measure the Pitch of a Screw Propeller. Describes a method employed in Scotland. 500 w. Am Mach—June 21, 1900. No. 34923.

Improvements in Screw Propulsion. I. McKim Chase. Considers how to increase the efficiency of screw propellers. Ill. 1300 w. Marine Rev—June 21, 1900. No. 34943.

Relief Ship.

Relief Ship for India's Starving. Illustrates and describes the S. S. "Quito," now en-route to Bombay with 200,000 bushels of corn. 350 w. Marine Engng—June, 1900. No. 34637 C.

Sea-Power.

The Study of Sea-Power. Translated from *Marine Rundschau*. A scientific and historical study. 8000 w. Jour of U. S. Art—May-June, 1900. Serial. 1st part. No. 34551 D.

Sea Trial.

Description of a Full Speed Sea Trial. From the *London Globe*. Descriptive. 1500 w. Marine Rev—June 21, 1900. No. 34942.

Shell Fire.

Lessons from the Belleisle. Editorial on the experiments made to determine the effect of gun fire. Ill. 2000 w. Engr, Lond—June 15, 1900. No. 34998 A.

The Belleisle Experiments. An illustrated description of the effects of the firing and account of the damage. 3000 w. Engr, Lond—June 8, 1900. No. 34912 A.

Ship-Building.

The Ship Building Yards of the United States. Waldon Fawcett. A summary of conditions and progress, with statistics of work in hand and in prospect, and fully illustrated descriptions of all the larger yards of the country and of their equipment. Part 1. 5000 w. Ill. The Engineering Magazine—July, 1900. No. 34757 B.

Cambering of Steamship's Keels. An account of an English high court decision in a case of special interest to naval architects. 2500 w. Marine Rev—June 28, 1900. No. 35081.

Shipbuilding in Germany. George Crouse Cook. Illustrates and describes Howaldtswerke at Kiel and the work 1200 w. Marine Rev—June 14, 1900. No. 34876.

Ship Building on Inland Rivers. Waldon Fawcett. Review of the work, showing a very promising outlook. Ill. 2200 w. Am Mfr & Ir Wld—June 7, 1900. No. 34695.

Unique Engineering Feat. Illustrates and describes the rapid work in cutting the steamship "Indiana" in two and pulling the sections apart 40 feet. 1000 w. Naut Gaz—June 14, 1900. No. 34846.

Shipping.

Shipping in Japan. Important facts relating to Japanese and foreign shipping. 1700 w. Engng—June 15, 1900. No. 34990 A.

Steamer.

Magnificent Coastwise Steamer. Illustration and description of the new Boston and Portland Propeller, "Governor Dingley." 1300 w. Naut Gaz—May 31, 1900. No. 34521.

New Type Propeller Steamer. Illustration and description of the "Pennsylvania," a speedy inland passenger boat, in operation on Chesapeake Bay. 1900 w. Naut Gaz—June 28, 1900. No. 35080.

MECHANICAL ENGINEERING

AUTOMOBILISM.

See also Special Motors, below.

Accumulators.

The Construction of Electric Accumulators. The interest of the accumulator to the automobilist, and an account of its development. 3000 w. Auto Jour—June, 1900. No. 35058 A.

Acetylene.

Acetylene and Its Adaptability as a Motive Power for Vehicles. E. C. Oliver. Reviews the history of acetylene, its manufacture, properties, etc., and discusses its use in motors. 2400 w. Horseless Age—June 20, 1900. No. 34947.

Some Properties of Acetylene. Herbert L. Towle. Considers generators, reports tests, etc. 2700 w. Horseless Age—June 20, 1900. No. 34950.

The Accumulators of Acetylene. From *Echo des Mines*. Methods of storage and transport are considered. 800 w. Horseless Age—June 20, 1900. No. 34953.

Will Acetylene Be the Coming Power for Motor Vehicles? D. N. Long. Presents the advantages for power purposes thus far demonstrated. 1800 w. Horseless Age—June 20, 1900. No. 34948.

Charging Stations.

Electric Automobiles in Boston. An illustrated account of the work and experience of the New England Electric Vehicle Transportation Company. 2300 w. Elec Wld & Engr—June 16, 1900. No. 34842.

Competitions.

Motor Car Competitions in France. G. Forestier. Reports two competitions, showing conveyances can now be propelled by mechanical power with greater economy than by horses. 1200 w. Am Mfr & Ir Wld—May 31, 1900. No. 34574.

Fuels.

Acetylene and Alcohol Versus Gasoline as Fuels. Isaiah L. Roberts. A comparison of the value of petroleum, acetylene and alcohol as fuels for use in the propulsion of self-moving vehicles by explosion in the cylinders of their engines, and use as a fuel to generate steam. 2000 w. Horseless Age—June 20, 1900. No. 34946.

Acetylene and Gasoline. L. Berger. A comparison. 600 w. Horseless Age—June 20, 1900. No. 34951.

On some French Experiments on Acetylene and Alcohol as Motor Fuels. P. M. Heldt. Discusses the cost and calorific power. 2000 w. Horseless Age—June 20, 1900. No. 34949.

Generators.

Acetylene Generators for Motor Vehicles. W. F. Cooper. Discusses the classes of generators used. 1000 w. Horseless Age—June 20, 1900. No. 34952.

Horseless Carriages.

Automobiles for the Average Man. Cleveland Moffett. Facts about horseless carriages, with their advantages and their disadvantages. Ill. 3800 w. Rev of Revs—June, 1900. No. 34549 C.

Locomotion.

Modern Locomotion. David Solomons. Excerpt from a paper before the Anglo-French Assn. Concerning motor cars, the power, steering mechanism, and other points. 3000 w. Auto Jour—June, 1900. No. 35061 A.

Motive Power.

The Automobile. R. H. Thurston. A discussion of the types of motor, finding use at present, the cost of operation, rated powers, etc., and statement of points proved in its construction and use. 13800 w. Sib Jour Engng—June, 1900. No. 35034 C.

Motor-Carriage.

A New German Motor Carriage. Illustrates and describes a vehicle designed by Vollmer for ascending heavy grades regardless of the character of the road. 800 w. Auto Mag—June, 1900. No. 34546 C.

Motor Cars.

The Manufacture of Motor Cars. The harm to the industry from the lack of technical education by many taking up this work. 1700 w. Auto Jour—June, 1900. No. 35060 A.

Paris Cabs.

Electric Cab System of Paris. Illustrated description of the cab adopted, and the electric plant for charging the batteries. 1500 w. Sci Am—June 2, 1900. No. 34506.

Paris Exposition.

Automobile Conveyance in the Interior of the Exposition. Brief illustrated description of the rolling platform and the electric railway. 1600 w. Auto Mag—June, 1900. No. 34544 C.

Motor Cars at Vincennes. Brief account of the trials of touring vehicles. 1500 w. Engr, Lond—May 25, 1900. No. 34607 A.

Progress.

Trend of Progress of the Automobile. R. H. Thurston. Part first considers the design, running gear, type of motor, etc. 1600 w. Auto Mag—June, 1900. Serial. 1st part. No. 34545 C.

Trials.

Proposed Trials of Motor Vehicles. Gives the programme of trials to be held in June, 1901, by the Liverpool Self-Propelled Traffic Assn. 1800 w. Engr, Lond —June 15, 1900. No. 34999 A.

HYDRAULICS.

Turbines.

Turbine Construction (Die Weltausstellung in Paris 1900 Turbinenbau). Prof. E. Reichel. A general review of turbine construction and the present state of the art; with references to some of the exhibits at Paris. 3000 w. Zeitschr d Ver Deutscher Ing—May 26, 1900. No. 34714 D.

MACHINE WORKS AND FOUNDRIES.

Brass.

Brass Founding—Gates and Gating. C. Vickers. Illustrated description of a good method of gating a mold. 1400 w. Am Mech—June 28, 1900. No. 35064.

Brass Furnaces. Paul Wever. Particulars concerning furnaces in use on the continent of Europe, but little known in the United States. Ill. 1800 w. Foundry—June, 1900. No. 34547.

Cams.

Analysis of the Cams of the Geometric Boring Tool. J. B. Taylor. Explanatory notes. 1100 w. Am Mach—June 14, 1900. No. 34826.

Castings.

Open-Hearth Steel Castings. E. C. Wheeler. Reviews the advances made in this industry and the uses to which the castings are applied. 3700 w. Ir Trd Rev—June 14, 1900. No. 34836.

The Mixing and Melting of Iron for Hydraulic Work. R. G. Cunningham. Read before the Am. Found. Assn. Considers the effects of constituents of iron upon castings. 1800 w. Ir Age—June 7, 1900. No. 34619.

Conveyors.

Conveyors in the Foundry. Dr. R. Moldenke. Reviews the uses for which the apparatus is adapted in foundry work. 1500 w. Ir Trd Rev—June 14, 1900. No. 34837.

Crane-Hooks.

Crane Hooks. C. F. Blake. Describes a method applicable to any short piece of mechanism eccentrically loaded, whether in tension or compression. 800 w. Am Mach—June 14, 1900. No. 34827.

Cranes.

Cranes. See Power and Transmission, below.

Drawing Office.

Drawing Office System of the Bullock Electric Manufacturing Company. W. H. Warren. Describes some features of the room and its furnishings, and the system used. 3800 w. Am Mach—June 7, 1900. No. 34690.

Founding.

Training Students in the Principles of Founding. Thomas D. West. Read at the Chicago meeting of the Am. Found. Assn. On the desirability of colleges training in this art. 2500 w. Ir Trd Rev —June 7, 1900. No. 34669.

The Properties and Uses of Logarithmic Cross Section Paper. J. A. Brown. An explanation of the manner in which results are obtained and the uses to which it may be applied. 1600 w. Am Mach—June 21, 1900. Serial. 1st part. No. 34920.

Foundry Chemists.

The Training of Foundry Chemists. Edward Kirk. Read at the Chicago meeting of the Am. Found. Assn. Also discussion by Thomas D. West, and communication from Robert H. Richards. 3600 w. Ir Trd Rev—June 28, 1900. No. 35070.

Fuel.

The Real Fuel Ratio. L. C. Jewett. Read at Chicago meeting of the Am. Found. Assn. Discusses what takes place in an effort to reduce the fuel ratio, and gives a table based on heats of 20 tons a day and coke at $4 a ton. 800 w. Ir Trd Rev—June 21, 1900. No. 34925.

Gears.

A System of Cutting Bevel Gears with Rotary Cutters. Herbert Innes Jacques. Illustrates and briefly describes a method by means of which bevel wheels may be cut, it is believed, with the nearest approach to accuracy obtainable with rotary cutters. 1700 w. Am Mach—June 7, 1900. No. 34689.

Cutting Spiral Gears on the Lathe. George R. Martin. Illustrated description of the work. 400 w. Am Mach—June 21, 1900. No. 34921.

Ingots.

Ingots for Gun Tubes and Propeller Shafts. F. J. R. Carulla. Read before the Iron and Steel Inst. Reports experiments made and discusses the forms found to best answer the required conditions. 1200 w. Col Guard—June 1, 1900. No. 34817 A.

Labor.

Settlement of the Machinists' Strike in the United States. Full text of the agreement reached by the arbitrators, with editorial pointing out its influence for lasting harmony, and explanation of variations between the official document and one put forth by the men. 2300 w. The Engineering Magazine—July, 1900. No. 34759 B.

The Official Agreement of the Arbitration Board. Text of the resolutions adopted. 1500 w. Am Mach—June 28, 1900. No. 35062.

Lathe.

A Spindle-Lathe with 150 Millimeters Height of Centers (Leitspindelbank von 150 mm Spitzeuhöhe). C. Schalz. A very well illustrated description of a metal lathe having a bed of the American pattern in general, but with various modifications. 1500 w. 1 plate. Zeitschr d Ver Deutscher Ing—May 26, 1900. No. 34715 D.

Milling Machines.

More Early Milling Machines. E. G. Parkhurst. Illustrates and describes the first improvements made in these machines. 1300 w. Am Mach—June 28, 1900. No. 35063.

Oil Slings.

The Design of Oil Slings. Edwin Rust Douglas. Describes experiments made to find the cause of failure in devices used and to determine the preventive. 1000 w. Am Mach—June 21, 1900. No. 34922.

Pipe Founding.

Some Notes on Pipe Founding. E. Kebler. Read before the Foundrymen's Assn, England. Illustrated description of modern practice. 1600 w. Ir & Coal Trds Rev—May 25, 1900. No. 34610 A.

Sheet Metal.

Pressure and Power Required to Roll Sheet Metal. W. P. Richardson and E. K. Wennerlund. Experiments described were made to determine the pressure required to reduce various metals, by cold rolling, and to measure the power absorbed by the rolling-mill, and the difference when provided with roller bearings. 1800 w. Engs' Year Book, Univ of Minn—1900. No. 35056 E.

Shop Lighting.

Artificial Light, with Special Reference to Engineers' Shops. A. E. A. Edwards. Read before the Birmingham (Eng.) Assn. of Mech. Engs. Considers the reflecting power of various surfaces and colors, shades, height, different illuminants, etc. 4200 w. Gas Wld—June 2, 1900. No. 34806 A.

Shops.

Gothic Works, Norwich, England. Illustrated description. 1700 w. Engr, Lond—June 8, 1900. No. 34911 A.

The New Erecting Shop of the H. K. Porter Company. Illustration, plan and brief description of a shop having longitudinal tracks served by overhead cranes. 250 w. R R Gaz—June 22, 1900. No. 34970.

The New Mechanical Engineering Shops of the University of Minnesota. J. J. Flather. Description with plans. 700 w. Engs' Year Book, Univ of Minn—1900. No. 35055 E.

Shop System.

Another Shop System. A. L. Graffam. Explains the foundation of a system adapted to machine tool building, special machinery and jobbing. 3000 w. Am Mach—June 28, 1900. No. 35066.

Works Management.

Commercial Organization of the Machine Shop. Hugo Diemer. Part 2 of Prof. Diemer's series deals with the production department bills of material. He discusses the listing of material and tools, forms for bills of material, services and record, the duties of material clerks and the cheapening of manufacture by duplication. 3000 w. The Engineering Magazine—July, 1900. No. 34758 B.

Foundry Management. J. A. Murphy. Read at the Chicago meeting of the Am. Found. Assn. Discusses true and false economics, materials, tools, etc. 2500 w. Ir Age—June 14, 1900. No. 34833.

MATERIALS OF CONSTRUCTION.

Boiler Plates.

Open-Hearth Steel Boiler Plates. T. L. Coudron. A comparison of the specifications proposed by the Am. Committee of the Inter. Assn. for Testing Materials with the Standard Specifications of the Am. Ry. Mas. Mechs.' Assn and others. Also editorial. 3500 w. R R Gaz—June 22, 1900. No. 34971.

Crystallization.

Crystallization of Metals. Edward B. Gilmour. Presented at the Chicago meeting of the Am. Found. Assn. Incidents from the writer's experience, and suggestions helpful to molders. Ill. 1100 w. Ir Age—June 14, 1900. No. 34832.

Lead.

Ornamental Lead and Lead-Casting. F. W. Troup. Read before the Birmingham (Eng.) Archt. Assn. Historical review, quoting from various authors, with illustrated description of work. 10000 w. Jour Roy Inst of Brit Archts—May 12, 1900. No. 34618 B.

Pig Iron Fracture.

Indications of Fracture in Pig Iron. Edward Kirk. How the chemist can utilize knowledge of fracture indications. 1700 w. Am Mfr & Ir Wld—June 21, 1900. No. 34976.

MEASUREMENT.

Econometer.

Arnett's Gas Weighing Econometer. A. Bement. Report of its value as a guide for managing fires and other uses, by a writer who has had experience with the instrument. 900 w. Sib Jour of Engng—June, 1900. No. 35031 C.

Manometer.

Notes on Lead Smelting and Gold and Silver Refining. Malvern W. Iles. Illustrated description of an instrument devised by M. S. Fallis, in which the pressure is balanced by gravity. 1800 w. Eng & Min Jour—June 30, 1900. No. 35078.

Pyrometers.

Practical Experience with Pyrometers. William H. Zimmer. Read before the Am. Ceramic Soc. Records the writer's experience with Seger cones and the Le Chatelier pyrometer. Also discussion. 7500 w. Brick—June, 1900. No. 34556.

Some Registering Apparatus for the Registry of High Temperatures. Albert Granger, in *La Ceramique*. Illustrated description of several instruments but slightly known. 900 w. Brick—June, 1900. No. 34557.

POWER AND TRANSMISSION.

Bearings.

Hot Bearings. H. Rolfe. The paper deals with causes of heating in detail. General discussion follows. Ill. 35000 w. N. Y. R R Club—May 17, 1900. No. 35028.

Compressed Air.

A Diagram for Solving Compressed Air Problems. J. A. Brown. Explanatory. 900 w. Am Mach—June 26, 1900. No. 35065.

Some Notes on the Compression of Air. E. C. Sickles. Personal experience with the practical operation of air compressors. 1700 w. Sib Jour of Engng—June, 1900. No. 35033 C.

Cranes.

Cranes at the Paris Exposition of 1900 (Die Weltausstellung in Paris 1900. Hebemaschinen). H. Kammerer. A general description of cranes, windlasses and other hoisting machines at the Exposition, with a table and plan. 1800 w. Zeitschr d Ver Deutsche Ing—May 19, 1900. Serial. 1st part. No. 34712 D.

The 30-ton Electric Crane in the French Section of Machinery Hall, Paris (Grue Titian Electrique de 30 Tonnes de la Salle des Machines La Bourdonnais). Alfred Boudon. A well illustrated description of this large traveling cantilever crane. 1500 w. 1 plate. Génie Civil—May 19, 1900. No. 34749 D.

Fly-Wheel Accident.

The Breaking of a Fly-Wheel (Ueber den Bruch eines Schwungrades). H. Hagens. An illustrated description of a fly-wheel accident in an electric power station at Königsberg, Prussia. 600 w. Zeitschr d Ver Deutscher Ing—May 12, 1900. No. 34710 D.

Gears.

Inertia Stress of Electric Gears. J. H. Macalpine. A statement of the problem, investigations made, methods used, etc. 13600 w. Jour Am Soc of Nav Engs—May, 1900. No. 34650 H.

The Strength of Gear Teeth. Robert A. Bruce. An investigation based on equation given in paper of Wilfred Lewis. 2000 w. Am Mach—May 31, 1900. No. 34513.

Pneumatic Tubes.

Pneumatic Transmission in Underground Tubes. Harrison Stidham. Reviews the history of pneumatic transmission, and describes the present practice in New York City and some of the problems encountered. Ill. 10500 w. Trans Assn of Civ Engs of Cornell Univ—1900. No. 35024 D.

Power Plants.

The Design of Steam Power Plants. Henry C. Meyer, Jr. Introduction to a series of articles on power-plant design, outlining the considerations governing the location of plants, and the methods of purchasing apparatus. 3600 w. Eng Rec —June 23, 1900. Serial. 1st part. No. 34918.

Rock-Drill.

The Gas Rock-Drill. Description given by Mr. Consul Powell in his report on the trade and commerce of Philadelphia. 1200 w. Col Guard—June 8, 1900. No. 34907 A.

Windmills.

Windmill Power. E. C. Murphy. Illustrates and describes types of windmills, notes some uses to which they may be applied, and gives data from experimental tests. 2500 w. Trans Assn of Civ Engs of Cornell Univ—1900. No. 35022 D.

SPECAL MOTORS.

Blast-Furnace Gas.

Utilization of Blast Furnace Gas in Engines. Emile Demenge. From a lecture to the Société Industrielle de l'Est de la France. Observations on the quality and quantity present and future utilization, principal engines used and blowing engines. Ill. 5000 w. Col Guard—May 25, 1900. No. 34602 A.

Gas Engines.

A Central Station Electric Plant Operated by a Gas Engine. J. C. Small. Read before the Western Gas Assn. Experience of the writer, with suggestions. Also discussion and letters on this subject. 4800 w. Pro Age—June 15, 1900. No. 34845.

The Efficiency of the Gas Engine. Ed. C. de Segundo. A comparison of the efficiency of the gas engine and steam engine, and an explanation of what is meant by "efficiency" as here used. 1200 w. Elec Rev, Lond—June 15, 1900. No. 35012 A.

Gas Engine Tests.

Test of Large Cockerill and Westinghouse Gas Engines. R. A. Millar and C. S. Gladden. An account of tests of two engines of exceptionally large power, with principal results. 2000 w. Sib Jour of Engng—June, 1900. No. 35030 C.

Heat Engines.

The Imperfections of the Cycles of Heat Motors. The "Economical Motor" (Imperfections des Cycles des Moteurs Thermiques. Le "Moteur Economique"). O. Duperrow. A general discussion of the theory of heat engines, with special reference to a type invented by the author, in which he endeavors to combine the advantages of steam and gas engines. Serial. 2 parts. 6000 w. Génie Civil—May 26, June 2, 1900. No. 34751 each D.

Heat Utilization.

Utilizing the Waste Heat from the Gas Engine. Alton D. Adams. An analysis of the heat-losses and a practical suggestion of means for recovering them, with exact data of the building space to be heated per horse power of engine. 2700 w. The Engineering Magazine—July, 1900. No. 34760 B.

Oil Engines.

Two-Stroke Oil Engines. The advantages and the practical difficulties are considered briefly. 1500 w. Auto Jour—June, 1900. No. 35059 A.

STEAM ENGINEERING.

Accidents.

Accidents to Steam Engines. W. H. Wakeman. Illustrated account of accidents and the methods of repairing them. 1200 w. Power—June, 1900. No. 34523.

Boiler Explosion.

Disastrous Boiler Explosion on the Austrian Torpedo Boat "Adler." J. Heinz. An illustrated account of a disaster that occurred while the vessel was steaming in the Adriatic Sea, on July 22, 1899. 1200 w. Marine Engng—June, 1900. No. 34638 C.

Boilers.

Preparing Boilers for Periods of Idleness. Suggestions and detailed description of operations necessary to leave a boiler in proper condition for starting when needed. 2500 w. Engr, U. S. A.—June 15, 1900. No. 34897.

Chimneys.

The Height and Area Required for Chimney Draft. H. G. Brinckerhoff. Read at meeting of the N. E. Cotton Mfrs.' Assn. Suggestions for the designing of chimneys for meeting stated conditions. 2500 w. Power—June, 1900. No. 34522.

Compression.

The Influence of Compression in Cylinder Clearance Spaces Upon Steam Consumption per I. H. P. Extracts from notes by B. F. Isherwood and Prof. Develshauvers-Dery. 2000 w. Jour Am Soc of Nav Engs—May, 1900. No. 34648 H.

Condensation.

Cylinder Condensation. An explanation of jacket action and the effects of condensation. 1600 w. Elec Rec, Lond—June 8, 1900. No. 34900 A.

Engine Tests.

Tests of a 3000 Horse-Power Engine in the Luisenstrasse Central Station, Berlin (Stehende Dampfdynamomaschinen von 3000 PS in der Zentrale "Luisenstrasse" der Berliner Elektrizitätswerke). A short account, with tables, of tests made of a vertical triple expansion engine. 400 w. Zeitschr d Ver Deutscher Ing—May 12, 1900. No. 34711 D.

Fuels.

The Performance of Boilers, Judged from a Chemical Standpoint (Zur Beurteilung der Leistung von Dampfkesseln vom Chemischen Standpunkt aus). H. Bunte. A very thorough review of the chemical composition and calorific power of fuels, and the composition and temperature of chimney gases, with full tables. 5000 w. Zeitschr d Ver Deutscher Ing—May 26, 1900. No. 34717 D.

Governors.

A New Measure of Good Quality in Governors. R. H. Smith. An explanation of measures of governor good quality based on geometric sensitiveness, force-power, energy-power and stability. 2800 w. Engr, Lond—May 25, 1900. No. 34603 A.

Liquid Fuel.

Liquid Fuel Apparatus of S. S. "Cardium." Illustrated description of apparatus and plan. 800 w. Engr, Lond—May 25, 1900. No. 34606 A.

Multiple Expansion.

Receiver Drop in Multiple Expansion Engines. R. L. Weighton. Explains results obtained from recent trials on experimental engines at the College of Science, Newcastle-upon-Tyne, made to determine the most economical point of steam cut-off Also discussion. 8500 w. Trans N. E. Coast Inst of Engs & Shipbuilders—April, 1900. No. 34643 F.

Packing.

Piston Rod and Valve Stem Packing. C. B. Conger. Describes the two general types of metallic rod packing in use, and the care it needs. 1500 w. Loc Engng—July, 1900. No. 35083 C.

Paris Exposition.

Power Features of the Paris Exposition. W. H. Donner. A well-illustrated description of boiler and engine plants characteristic of continental practice, with text explanations of the striking features of the several installations. 3000 w. The Engineering Magazine—July, 1900. No. 34761 B.

Prime Movers at the Paris Exposition. A review of the various exhibits. 4000 w. Engr, Lond—June 8, 1900. Serial. 1st part. No. 34908 A.

The Engines of the Paris Exposition. Illustrates and describes steam engineering exhibits of interest. 4500 w. Power—July, 1900. No. 35077.

Steam Engines.

The Story of the Steam Engine. Its history and development are reviewed. 2500 w. Loc Engng—June, 1900. Serial. 1st part. No. 34594 C.

Traction Power Plant.

See Electrical Engineering, Generating Stations.

Triple Expansion.

High Speed Vertical Triple Expansion Engine of 1500 Horse Power (Schnellgehende Stehende Dreifach-Expansionsmaschine von 1500 PS). Leopold Kliment. A well illustrated description of engines for driving pairs of dynamos in a Vienna central station. 1000 w. 3 plates. Zeitschr d Ver Deutscher Ing—June 2, 1900. No. 34719 D.

MISCELLANY.

Balloons.

The Dragon Balloon. A. Von Parseval. Illustrates and describes the characteristics and principles of action. 2300 w. Jour of U. S. Art—May-June, 1900. Serial. 1st part. No. 34552 D.

Carborundum.

Manufacture of Carborundum at Niagara Falls. Illustrated description of the method. 2200 w. Sci Am—June 16, 1900. No. 34831.

Laboratory.

The Engineering Laboratory of the Berlin Technical High School. Information concerning this establishment and the work done in it. 3000 w. Engng—June 8, 1900. No. 34901 A.

Ordnance.

Vickers' Ordnance at the Paris Exposition. Illustrated description of the fine exhibit of modern ordnance. 2500 w. Engng—June 8, 1900. No. 34902 A.

Roller Bearings for Artillery. E. W. Hubbard. Illustrates and describes a bearing believed to be especially adapted to this service and capable of greatly reducing artillery draft. 700 w. Jour of U. S. Art—May-June, 1900. No. 34550 D.

The Dismountable Gun of the State of Congo. Illustrates and describes a gun made dismountable, that it may be easily carried by men or animals. 800 w. Sci Am Sup—June 9, 1900. No. 34680.

Paris Exposition.

Paris Exposition of 1900. Albert Shaw. A general review of the Exposition, with illustrations, making some comparisons with the Chicago Exposition, and others held in Paris. 5000 w. Rev of Revs—June, 1900. No. 34548 C.

The Paris Exposition of 1900. Andrew D. Fuller. Illustrated description of some of its general features. 2000 w. Mach, N. Y.—June, 1900. No. 34559.

Postage Distributer.

Postage Stamp and Postal Card Distributer. Illustrates and describes an apparatus invented by M. de Janisch, which has overcome the many difficulties and provided for the automatic supply of stamps and postal cards. 1700 w. Sci Am Sup—June 30, 1900. No. 35069.

Wood Screws.

See Architecture, Construction.

MINING AND METALLURGY

COAL AND COKE.

Alabama.

The Alabama Coalfield. On the importance of this field and the effect it is destined to have upon the foreign as well as the domestic supply. 3500 w. Engng—June 8, 1900. No. 34905 A.

Belgium.

Neuville Pit of the Grand-Mambourg-Sablonniere Colliery, Belgium. Notes of a visit, describing the Reumaux safety applinace for the prevention of over-winding, and other interesting equipments. Ill. 1600 w. Col Guard—June 1, 1900. No. 34814 A.

Coking.

By-Product Coking in Western Pennsylvania. William Gilbert Irwin. Considers the advantages of the by-product ovens over the best hive oven, and the economic superiority of the system. Ill. 1200 w. Eng & Min Jour—June 16, 1900. No. 34878.

Costs.

Colliery Costs. Present and Prospective. A discussion of English mining

costs. 3200 w. Col Guard—June 1, 1900. No. 34816 A.

The Cost of Coal. Norton H. Humphrys. Discusses how the increased price of coal has affected gas-works, and means of covering the increase in expenditure without raising the price of gas. 3000 w. Jour Gas Lgt—June 12, 1900. No. 34939 A.

Electrical Machinery.

See Electrical Engineering, Power Applications.

Gob Workings.

Drawing Gas from Gob Workings by Bore Holes. Charles Connor. Read before the Western Penna. Cent. Min. Inst. Explains certain conditions under which this method is most effective and cheapest. 1600 w. Mines & Min—June, 1900. No. 34624 C.

Ireland.

The Coalfields of Ireland. An outline of the general character of these coalfields, and of the conditions under which they occur. Ill. 2600 w. Col Guard—June 15, 1900. Serial. 1st part. No. 34991 A.

Kansas.

Correlative Relations of Certain Subdivisions of the Coal Measures of Kansas. Charles R. Keyes. Calls attention to similarity of results obtained 40 years ago and conclusions arrived at by recent workers. 2300 w. Am Geol—June, 1900. No. 34652 D.

Michigan.

The Coal Basin of Michigan. A. C. Lane. Gives a sketch map showing the approximate extent of the coal basin, information concerning its deposits, characteristics and development. 1800 w. Eng & Min Jour—June 30, 1900. Serial. 1st part. No. 35079.

Mine Statistics.

Suggestions for Improved Coal Mining Accident Statistics. F. L. Hoffman. Also editorial. A discussion of needed improvements in methods of compiling, with suggestions of value. 3500 w. Eng & Min Jour—June 2, 1900. Serial. 1st part. No. 34571.

New Zealand.

Notes on the Coalfields of New Zealand. James Park. Read before the Inst. of Min. and Met., London. Concerning the quality and quantity of coal available. 2200 w. N. Z. Mines Rec—April 16, 1900. No. 34691 B.

Power Plant.

Utilizing a Feeder for Driving a Winch. Illustrates and describes an installation of a turbine-driven winch. 1000 w. Col Guard—June 1, 1900. No. 34815 A.

Production.

The Coal Production of the Principal Countries of the World. Statement showing what has been the production in the five principal coal producing countries in the years 1897, 1898 and 1899. 2200 w. Col Guard—May 25, 1900. No. 34601 A.

United States Coal Production in 1899. Completed tables of production showing that for the first time Great Britain has taken second place and the United States leads. 1000 w. Eng & Min Jour—June 2, 1900. No. 34569.

Queensland.

Coal Mining in Queensland. The great extent of the deposits, present output, legislation, etc. 1400 w. Col Guard—June 8, 1900. No. 34906 A.

Co-operative Coal Mining in Queensland. Harrison F. Bulman. Explains the manner of conducting the Aberdare Colliery at Blackstone. Also describes method of working. 1500 w. Col Guard—June 15, 1900. No. 34992 A.

Roentgen Tests.

Examination of coal by Röntgen Rays. Investigations of F. Kotte as published in *Stahl und Eisen*. Ill. 400 w. Sci Am—June 23, 1900. No. 34956.

COPPER.

Lake Superior.

Lake Superior Mining Region. William Kelly. The present condition of the mining industry as compared with former years. The introduction of new machinery and methods by which the output has been increased and the cost of production lessened. 3800 w. Mines & Min—June, 1900. No. 34625 C.

Mexico.

The Nacosari Mines, Mexico. H. B. Layton. An illustrated account of the development of a large copper mine. 1600 w. Eng & Min Jour—June 9, 1900. Serial. 1st part. No. 34666.

Smelting.

The Pyritic Smelting of Copper Ores. C. C. Lougridge. Explains the object of pyritic smelting, the constituents of the ores, the thermal relation and estimation of the carbonaceous fuel required, action of the furnaces, etc. 3000 w. Engng—June 15, 1900. No. 34986 A.

GOLD AND SILVER.

Assaying.

The Assaying of Gold and Silver Ores. William B. Gamble. Describes all the preparatory operations, the system of assay weights, the assay, and the care needed in the operations. 2200 w. Sci Am—June 2, 1900. No. 34505.

Australia.

Tarcoola Gold Field. Concerning a recently discovered gold field in South Aus-

tralia. Maps. 900 w. Aust Mine Stand—April 26, 1900. No. 34632 B.

Black Hills.

The Bear Butte Mineral Formation. Robert W. Barrell. An illustrated description of the interesting Black Hills mining region and an account of its peculiarities. 3400 w. Mines & Min—June, 1900. No. 34628 C.

California.

Mining on the California Gold Belt. W. H. Storms. An account of recent workings by improved methods. 1500 w. Min & Sci Pr—May 26, 1900. Serial. 1st part. No. 34512.

Cape Nome.

The Auriferous Sands of Cape Nome (Les Sables Aurifères du Cap Nome, Alaska). R. de Batz. A general description of the Cape Nome region and gold fields, with maps. 3500 w. Génie Civil—June 9, 1900. No. 34755 D.

Colorado.

The Geology and Vein Systems of the Mount Wilson Mining District, Colorado. Frank L. Nason. Illustrated description of this region and the character of the ore deposits. 2200 w. Eng & Min Jour—June 9, 1900. No. 34668.

Cyanide.

Precipitation of Gold from Cyanide Solutions. H. Watson. Discusses the methods at present in use, and the experiments tried by the writer. 1300 w. Mod Mach—June, 1900. No. 34554.

Deposits.

The Golden Mountain. William Bradford. An account of a great mining boom in the early '90's. Ill. 1700 w. Aust Min Stand—April 26, 1900. Serial. 1st part. No. 34633 B.

Dredging.

Dredging for Gold. J. W. H. Piper. On the advantage of the bucket-dredge as a gold producer. 2100 w. Aust Min Stand—May 10, 1900. No. 34924 B.

Dumps.

Working Over an Old Dump. Describes an old dump in California being worked with profit, though first worked closely and economically. Describes the process employed by the old company and the present method. Ill. 2800 w. Min & Sci Pr—May 26, 1900. No. 34511.

Lixiviating.

Lixiviating or Leaching Processes. J. Ohly. Remarks on various processes. 3500 w. Ores & Met—June, 1900. No. 34841.

New South Wales.

Temora Gold Field (N. S. W.). W. Green. Information concerning the geology of these deposits. 1200 w. Aust Min Stand—April 26, 1900. No. 34634 B.

Placers.

Gold Placers in Glaciated Regions. George H. Stone. Why they present different conditions from those which have not been affected by glaciation. Ill. 2700 w. Mines & Min—June, 1900. No. 34626 C.

Production.

Gold and Silver Production in 1899. Completed tables of production for the year for the United States, and for the world. 2500 w. Eng & Min Jour—June 2, 1900. No. 34568.

Russia.

Russian Laws on Gold Mining. Translation and condensation from a recent French publication giving information on this subject. 2200 w. U. S. Cons Repts, No. 754—June 13, 1900. No. 34821 D.

Smelting.

Notes on Lead Smelting and Gold and Silver Refining. Malvern W. Iles. Illustrates and describes apparatus for collecting solids from smoke and fumes. 1100 w. Eng & Min Jour—June 2, 1900. No. 34570.

Stamp Mill.

The Evolution of the 300-Stamp Mill on Douglas Island, Alaska. Henry Watson. Describes this new mill, giving an account of the crushing capacity and manner of operating. Ill. 2000 w. Min & Sci Pr—June 16, 1900. No. 34936.

IRON AND STEEL.

Blast-Furnace Gas.

See Mechanical Engineering, Special Motors.

Brown Ore.

Georgia's Brown Ore Fields. Interesting detailed description of the extensive deposits and their commercial character. 1400 w. Am Mfr & Ir Wld—June 7, 1900. No. 34696.

Competition.

American Engineering Competition. Lowthian Bell. From the London *Times*. A letter in defence of the British iron and steel trades. 2600 w. Ir & Coal Trds Rev—June 15, 1900. No. 35002 A.

Cupola Practice.

Concerning Cupola Practice in Bessemer Steel Works. S. M. Rodgers. Read and discussed before the Pittsburg Found. Assn. Considers the circumstances and conditions governing the manipulation of the cupola in the Bessemer steel works. 3000 w. Ir Trd Rev—June 21, 1900. No. 34926.

Germany.

The Iron Industries of Germany. In-

teresting statistics concerning production, imports and exports and related information. 3000 w. Ir Age—May 31, 1900. No. 34510.

Iron Trade.

The Iron Situation from a British Point of View. J. Stephen Jeans. Summarizes recent events, the trend of prices, supply and consumption all over the world, and the effect of prevailing high prices in checking constructive enterprise. 2700 w. The Engineering Magazine—July, 1900. No. 34764 B.

What Is the Competitive Outlook in the World's Iron and Steel Trades? or, more particularly, What is the Outlook for the British Iron Trade? H. J. Skelton. Read before the British Iron Trade Assn. Discussion of subject. 7200 w. Ir & Coal Trds Rev—June 15, 1900. No. 35001 A.

Minette District.

The Minette District of Lorraine, Luxembourg and France. Illustrated account of the iron deposits, production, mining cost, etc. Map. 4700 w. Ir Age—June 28, 1900. Serial. 1st part. No. 35057.

Pennsylvania.

Iron in Western Pennsylvania. From *The News*, Scottdale, Pa. Gives history of early blast furnaces and account of ores found and their uses. 2000 w. Am Mfr & Ir Wld—June 21, 1900. No. 34977.

Stassano Process.

The Stassano Process for the Production of Iron and Steel. John B. C. Kershaw. Considers this process, being tried in Italy, and discusses the economy of the electric current when used for heating. 1700 w. Elec Rev—June 15, 1900. No. 35011 A.

MINING.

Accidents.

Scofield Mine Disaster. Don Maguire. Describes the disaster in the mines of the Pleasant Valley Coal Co., Scofield, Utah. 1800 w. Mines & Min—June, 1900. No. 34622 C.

The Red Ash Mine Explosion in West Virginia. Report of J. W. Paul on the explosion that occurred last March, killing 46 men. 2000 w. Eng & Min Jour—June 9, 1900. No. 34667.

Air-Doors.

Interlocking Mine Air-Doors. M. Martinet. Illustrated description of a method without any rigid part for transmitting motion. 600 w. Col Guard—May 25, 1900. No. 34600 A.

Concrete.

The Use of Concrete in Mining. Marcel Habets. From a communication to the Liége section of the Société des Ingenieurs de Liége. Its use for shaft-lining, underground engine-room, stoppings, lining a fan drift, etc., and the advantages are presented. Ill. 2500 w. Col Guard—June 15, 1900. No. 34993 A.

Gallery.

The Construction of a Subterranean Gallery Which Is to Connect the Lignite Mines of Gardanne, near Marseilles, with the Sea (Mines de Lignite de Gardanne (Bouches-du-Rhone) Construction d'une Galerie Souterraine Destinée à Relier la Concession à la Mer). H. Schmerber. A long and well illustrated account of methods of construction and apparatus employed. Serial. 3 parts. 6000 w. Génie Civil—May 26, June 2, 9, 1900. No. 34752 each D.

Hoisting Machinery.

Hoisting with a Driving Wheel (Die Föderung mit Treibscheibe). A. Ehrlich. A well illustrated description of the machinery used in hoisting the cages in shafts by an endless rope driven by a large wheel. 3000 w. Zeitschr d Ver Deutscher Ing—May 26, 1900. No. 34718 D.

Shaft Sinking.

Sinking Parker Shaft at Zinc Mines, Franklin Furnace, New Jersey. J. A. Van Mater. An account of the means used to control the inflow of water in the shaft, plans of timbering, placing holes for blasting, and method of firing by electric dynamo. Ill. 5000 w. Mines & Min—June, 1900. No. 34621 C.

Timbering.

On the Theory of Timbering. Henry Louis, in the *Colliery Manager*. The need of data at present unknown, which can only be derived from experiment. 2800 w. Mines & Min—June, 1900. No. 34627 C.

Wire Rope.

Wire Rope—Its Uses, Abuses and Care. Justin S. Doe. Read before the Ohio Inst. of Min. Engs. The origin, construction, and need of proper care to preserve it. 2000 w. Mines & Min—June, 1900. No. 34629 C.

MISCELLANY.

Aluminum.

Aluminum in India. Report on the condition of the industry, by Alfred Chatterton. 1300 w. Jour Soc of Arts—May 25, 1900. No. 34612 A.

Recent Progress in the Aluminum Industry. Joseph W. Richards. Remarks on recent advances and improvements in methods. 2800 w. Jour Fr Inst—June, 1900. No. 34645 D.

British Columbia.

History of Progress of Mining in British Columbia. H. Mortimer Lamb. A

comprehensive review of the development of the region, including discoveries, exploitation, mining methods and equipment, and economic conditions, with many fine illustrations. 5400 w. The Engineering Magazine—July, 1900. No. 34762 B.

China.

The Value of Chinese Mining Concessions. John A. Church. A discouraging report of the mining outlook in China. 1100 w. Eng & Min Jour—June 23, 1900. No. 34984.

Clay.

The Clay-Working Industry of the Pacific Coast. Heinrich Ries. Facts in regard to the clay deposits and the extent of their utilization. 1500 w. Mines & Min—June, 1900. No. 34623 C.

Granite.

Granite and Granite Quarrying. F. T. Mallon. Concerning the selection of a site and related matters affecting success. 3300 w. Stone—June, 1900. No. 34872 C.

The Granites of Sweden. From *The Stonemason.* Information concerning the granite of Norway and Sweden. 800 w. Stone—June, 1900. No. 34873 C.

Nickel.

Nickel Mining in New Caledonia. Brief illustrated account of the deposits and ores in this South Sea island. 600 w. Eng & Min Jour—June 23, 1900. No. 34983.

Ore Deposits.

Horses and Breccia. An explanation of these terms, as applied to mining, and of their causes. 1000 w. Min & Sci Pr—June 2, 1900. No. 34674.

Production.

The Mineral Statistics of the United Kingdom for 1899. Extracts from the Home Office. Returns concerning persons employed, output and accidents. 1300 w. Ir & Coal Trds Rev—June 1, 1900. No. 34807 A.

United States Mineral and Metal Production. Tables showing the total production for 1899, comparing with the previous year. Also comments. 6200 w. Eng & Min Jour—June 9, 1900. No. 34665.

Siberia.

Siberian Mining Concession. Concerning concessions and the mining industry, the restrictions and the outlook. Does not advise Americans without capital to enter this field. 1600 w. U. S. Cons Repts, No. 754—June 13, 1900. No. 34820 D.

Smelting.

Smelting Process for Zinc Ores. Concerning the process invented by Emil E. Lungwitz for the smelting of refractory ores. 1500 w. Sci Am—June 9, 1900. No. 34675.

Sulphur.

The Production of Sulphur in England. An editorial explaining why the Anglo-Sicilian Sulphur Co. was formed, the process of recovery used, the product, etc. 2700 w. Engng—June 15, 1900. No. 34988 A.

Veins.

Enrichment of Mineral Veins by Later Metallic Sulphides. Walter Harvey Weed. From the *Bulletin of the Geol. Soc. of Am.* An explanation of chemical and mineralogic changes in deposits. 1200 w. Min Rept—June 21, 1900. Serial. 1st part. No. 34982.

Zinc.

Notes on the Ferrocyanide Titration of Zinc. Edmund H. Miller and E. J. Hall. Experiments made to find out the influence of hydrochloric acid and those salts most likely to be present on the estimation of zinc by titration with potassium ferrocyanide, using uranium acetate as an indicator. 1600 w. Sch of Mines Quar—April, 1900. No. 34896 D.

The Joplin Zinc District of Southwest Missouri. James H. Steele. An illustrated account of this district, which produces over one-third of the world's supply of zinc. 3400 w. Min & Sci Pr—June 9, 1900. No. 34822.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in April. Detailed list and classified summary. 3300 w. R R Gaz—June 8, 1900. No. 34641.

Fast Trains.

The Cost of Running Fast Trains. G. R. Hudson. Treats of results obtained on the test plant of the Chicago & North-Western Ry., in regard to fuel consumption. 800 w. Am Engr & R R Jour—June, 1900. No. 34581 C.

India.

Indian Railways. Comments on the influence of disasters that have visited the country, and information on the last report of the Railway Department. 1800 w. Engr, Lond—June 15, 1900. No. 34994 A.

Mineral Transport.

British Traders and British Railways, with Reference to the Control and Cost of Mineral Transport. John J. Jenkins. Read before the British Iron Trade Assn. Discusses the importance of the country acquiring the control of the railroads, and proposals for the purchase. Also general discussion. 7500 w. Ir & Coal Trds Rev—June 15, 1900. No. 35000 A.

MOTIVE POWER AND EQUIPMENT.

Adams' Train.

Adams' Air-Splitting Train. An illustrated description of the cigar-shaped train fitted up by Frederick U. Adams for reducing the resistance of the air. 700 w. R R Gaz—June 8, 1900. No. 34640.

Experimental Train for Testing Atmospheric resistance. Illustration of the train and an account of the trial run of forty miles between Baltimore and Washington. Also editorial. 1600 w. Sci Am —June 9, 1900. No. 34676.

Boilers.

Stationary Shop Boilers. F. W. Dean. A plea for the locomotive type of boiler in stationary service, claiming economy and commenting on statements made concerning them. 7500 w. R R Gaz—June 15, 1900. No. 34891.

Box Car.

Design for Standard Box Car. Committee report, with drawings. 400 w. Cent Ry Club—May, 1900. No. 34840 C.

Car-Axle Boxes.

Novelties in the Construction and Internal Arrangement of Wrought Iron Car-Axle Boxes for Railway and Tram Cars (Neuerungen in der Herstellung, Bauart und Inneren Einrichtung Schmiede-eiserner Achslager-Kasten für Eisenbahn-u. Strassenbahn-Fahrzeuge). F. Sürth. A paper before the Verein Deutscher-Maschinen-Ingenieure, giving a well illustrated description of recent German practice. 4500 w. Glaser's Annalen—June 1, 1900. No. 34746 D.

Cars.

American Railroad Cars at the Paris Exposition. Gives half-tone engravings of drawing showing the development of American cars, with description. 4000 w. R R Car Jour—June, 1900. No. 34823.

Combination Ballast and Gondola Cars, Wisconsin Central Ry. Illustrated description of a novel design. 700 w. Eng News—June 21, 1900. 34966.

Development of the Structural Steel Hopper Car. George I. King. Illustrated account of the development, giving interesting detailed information. 2000 w. Ry Age—June 22, 1900. No. 34978.

Double Deck Boarding Cars Built by and in Use on the St. Paul & Duluth R. R. Illustrated description. 600 w. Loc Engng—June, 1900. No. 34590 C.

Special Egyptian Railway Saloons. Illustrated detailed description of fine coaches. 900 w. Engr, Lond—June 15, 1900. No. 34996 A.

Coal Cars.

New 80,000 lb. Coal Cars, Norfolk & Western Ry. Illustrated detailed description. 900 w. R R Gaz—June 15, 1900. No. 34888.

Convention.

Annual Convention of the Master Car Builders' Association at Saratoga, N. Y. Extracts from reports, with editorial. 8500 w. Eng News—June 28, 1900. No. 35076.

Couplings.

Automatic Couplings on Mineral Railways. A statement referring to the Taff Vale Ry., with discussion of whether automatic couplings would be superior to the present system. 2000 w. Engr, Lond —May 25, 1900. No. 34608 A.

Draft Gear.

Freight Car Draft Gears. Edward Grafstrom. Discussion of present devices in use and the fundamental principles of an approved draft rigging. 1800 w. Am Engr & R R Jour—June, 1900. No. 34580 C.

Dynamometer Car.

The Dynamometer Car in Tests for Railroads. L. P. Breckenridge. Paper and discussion. The construction and operation of the car is discussed. Ill. 10800 w. Cent Ry Club—May, 1900. No. 34838 C.

New Dynamometer Car. Illustrated description of the novel features of a car recently completed by the Chicago & Northwestern Ry. 900 w. Am Engr & R R Jour—June, 1900. No. 34576 C.

Exhaust.

The Need for Further Tests on Locomotive Exhaust Arrangements. H. H. Vaughan. Urges a continuation of experiments in order to settle the best exhaust arrangements for draft producing purposes. 1600 w. Am Engr & R R Jour—June, 1900. No. 34585 C.

Firebox.

The Wide Firebox as a Standard. J. Snowden Bell. Reasons why it should be standard for all types of engines. 2400 w. Am Engr & R R Jour—June, 1900. No. 34586 C.

Freight Cars.

Center Plates and Side Bearings for Freight Cars. Substance of two committee reports presented at convention of Master Car Builders' Assn. 4500 w. Eng News—June 21, 1900. No. 34965.

Repairs to Steel Freight Cars. C. A.

Seley. Outlines a shop and equipment suited to most roads and required by the use of steel in car construction. 2100 w. Am Engr & R R Jour—June, 1900. No. 34583 C.

"Front End."

Turner's New Short "Front End." Presents its advantages. Ill. 800 w. Am Engr & R R Jour—June, 1900. No. 34587 C.

Fuel.

Coke for Locomotive Fuel. George L. Fowler. Reviews European practice and the results accomplished, and gives details of its use in America. Ill. 3500 w. R R Gaz—June 22, 1900. No. 34972.

Locomotive Building.

Welding Locomotive Frames in Place with Oil. D. P. Kellogg. Illustrated description of a system in use at the Southern Pacific shops. 1500 w. Loc Engng—June, 1900. No. 34591 C.

Locomotive Design.

A Decade of Car and Locomotive Construction. George L. Fowler. A review of American rolling stock during the past ten years, showing the improvements and changes. 2800 w. Ry Age—June 15, 1900. No. 34869.

An Outline of the Development of the American Locomotive. Half-tone reproduction of drawings on exhibition at the Paris Exposition, with descriptive remarks. 2400 w. Sci Am Sup—June 9, 1900. Serial. 1st part. No. 34678.

A Suggestion for Improvement in Locomotive Design. R. A. Smart. Concerning the use of a lighter valve and yoke. 900 w. Ry Age—June 15, 1900. No. 34870.

Consideration of Weight of Parts in Locomotive Design. W. H. Marshall. Outlines where savings can be effected and to what extent they may be carried. 1800 w. Am Eng & R R Jour—June, 1900. No. 34577 C.

Exhaust and Draft in Locomotives. Portions of the report of Edouard Sauvage, with editorial. Ill. 5500 w. R R Gaz—June 29, 1900. No. 35074.

Locomotive Development from 1890 to 1900. F. W. Dean. Reviews improvements made, increase in size, materials used, increase in speed, etc. 3800 w. Ry Age—June 15, 1900. No. 34867.

Locomotive Progress in Ten Years. R. H. Soule. Considers improvements made in design and construction that increase the power and reduce expenses. 1300 w. Ry Age—June 15, 1900. No. 34868.

Locomotives in 1900. M. N. Forney. Comments on problem arising from increase in size and weight. 2000 w. Am Engr & R R Jour—June, 1900. No. 34578 C.

What Is the Ideal Fast Passenger Engine? S. M. Prince, Jr. Illustrations and descriptive specifications of the Phila. & Reading passenger locomotive No. 218. Also criticism of Columbia and Atlantic types. 1500 w. R R Gaz—June 22, 1900. No. 34969.

Locomotive Performance.

Comparative Performance of Heavy and Medium Weight Locomotives. F. F. Gaines. An account of the performance of engines in mountain pushing service on the Lehigh Valley R. R. 700 w. Am Engr & R R Jour—June, 1900. No. 34584 C.

Locomotives.

An Old English Locomotive. W. B. Paley. Illustrated description of one of the first class of express passenger locomotives which the Great Northern Co. of England had when the line opened in 1852. 700 w. R R Gaz—June 8, 1900. No. 34642.

Atlantic Type Fast Passenger Locomotive. Dimensions, illustration and interesting details of engine on the Pennsylvania R. R., of Class E1, Atlantic Type. 4700 w. Am Engr & R R Jour—June, 1900. No. 34575 C.

Brooks Convertible Type Locomotives for Egyptian State Rys. Illustrated descriptions of an engine that can be converted from an Atlantic type having driving wheels 78 in. in diameter into a 10-wheeler having driving wheels either 69 or 60 in. in diameter. 1000 w. Ry & Engng Rev—June 16, 1900. No. 34866.

Compound Consolidation Locomotives for the Baltimore & Ohio. Illustrations and description of engines, interesting because of the large number built from a single design. 600 w. R R Gaz—June 15, 1900. No. 34887.

Compound Decapod—Minneapolis, St. Paul & Sault Ste. Marie Ry. Illustrated description. 800 w. R R Gaz—June 22, 1900. No. 34975.

Compound Duplex Locomotive for the McCloud River R. R. Engine for a California road with grades of 2 per cent. to 4 per cent. and curves of 15°. 350 w. Eng News—June 28, 1900. No. 35075.

Duplex Compound Locomotive for Seven Per Cent. Grades. Brief illustrated description. 250 w. Am Engr & R R Jour—June, 1900. No. 34588 C.

German Locomotive Exhibit at Paris. (Die Weltausstellung in Paris 1900. Die Deutsche Kollektioausstellung von Locomotiven). A well illustrated general description of the exhibit, with details of some of the locomotives. Serial. 1st part. 5500 w. 4 plates. Glaser's Annalen—May 15, 1900. No. 34743 D.

Great Consolidation Locomotives for the Pittsburg, Bessemer & Lake Erie

Railroad. Illustration and general description of the largest and heaviest locomotive yet built. 1100 w. R R Gaz—June 29, 1900. No. 35073.

Locomotive Engines at the Paris Exposition. Describes some of the noteworthy features of the exhibit. 3800 w. Engr, Lond—June 8, 1900. No. 34910 A.

Midland Locomotive at the Paris Exposition. Two-page engraving and views, with principal dimensions and particulars. 700 w. Engng—June 1, 1900. No. 34809 A.

Some Holland Locomotives. Brief illustrated description. 300 w. Loc Engng—June, 1900. No. 34596 C.

Ten-Wheel Locomotives for Sweden. General dimensions and illustrated description of engines for the Ystad Eslof Ry. 350 w. Am Engr & R R Jour—June, 1900. No. 34589 C.

Odd Styles of Locomotives. D. P. Kellogg. Illustrated description. 400 w. Loc Engng—June, 1900. No. 34595 C.

The Heaviest Locomotive in the World, Pittsburg, Bessemer & Lake Erie R. R. Principal dimensions, with illustration. 500 w. Eng News—June 21, 1900. No. 34964.

The New York, Ontario & Western Consolidation Engines. A study of the hauling capacity of these engines as compared with certain others, and a table giving particulars of recent consolidation engines. 800 w. R R Gaz—June 15, 1900. No. 34895.

Lubrication.

Lubrication and Hot Boxes. H. B. Hodges. A discussion of car journal lubrication and the prevention of hot boxes. 4500 w. R R Gaz—June 15, 1900. No. 34893.

Mixed Brakes.

Tests of Westinghouse and New York Triple Valves. A report of an important series of tests of air brake apparatus, with editorial discussion. 9500 w. R R Gaz—June 15, 1900. No. 34886.

Oil Fuel.

Locomotives Using Oil for Fuel. Treats of the apparatus used and the mechanical side, from the view of a coal burner engineer. 2200 w. Loc Engng—June, 1900. No. 34592 C.

Rating.

Locomotive Rating on the Mexican Central. Describes the system in use for keeping a record of the tractive power. 1300 w. R R Gaz—June 15, 1900. No. 34890.

Reports.

The Reports of the Master Mechanics' Association. Extracts from most of the reports, and from the president's address, and discussions. Also editorial. 31700 w. R R Gaz—June 29, 1900. No. 35072.

Shops.

Some Elements of Modern Shop Arrangements. Suggestions relating to systems of arrangement found convenient and necessary for modern work. 1500 w. R R Gaz—June 15, 1900. No. 34889.

The Shifting Arrangements at the Gleiwitz Railroad Shops (Das Verschubgeschäft in der Hauptwerkstatt Gleiwitz). H. Lach. An illustrated description of arrangements for shifting cars about the repair shops, in which electricity is employed to a great extent. 2500 w. 1 plate. Glaser's Annalen—May 15, 1900. No. 34745 D.

The Arrangement of Boiler Shops. F. M. Whyte. A discussion of the general arrangement of a boiler shop forming a part of a locomotive repair plant. 2200 w. Am Engr & R R Jour—June, 1900. No. 34582 C.

Passenger Car Repair Shops. Illustrated description of the shops of the Lake Shore and Michigan Southern Ry. at Buffalo, N. Y. 2000 w. R R Car Jour—June, 1900. No. 34824.

Speed.

The Economy of Speed. F. P. Roesch. Discusses methods of rating engines and their maintenance. 1600 w. Loc Engng—July, 1900. No. 35084 C.

Staybolts.

Best Method of Applying Staybolts. Opinions of Mr. Archie Baird, foreman boilermaker at the Topeka shops, with illustrations of experimental tests. 1200 w. Ry & Engng Rev—June 16, 1900. No. 34865.

Tenders.

Locomotive Tenders. William Forsyth. Illustrated description of recent improvements in design. 1400 w. Am Engr & R R Jour—June, 1900. Serial. 1st part. No. 34579 C.

Trucks.

Passenger and Freight Car Trucks; Their Principles and Design. General discussion with illustrations. 17600 w. N. Y. R R Club—April 19, 1900. No. 34693.

Water.

Pure Water for Locomotives by Evaporation. Editorial discussing the advantages and the possibility of using distilled water for locomotives. 2400 w. R R Gaz—June 22, 1900. No. 34973.

Water Brake.

Test of Water Brake. Frank F. Coggin. An account of a series of tests made to ascertain the retarding power of the water brake, made on the mountain division of the Maine Central R. R. 1000 w. Loc Engng—June, 1900. No. 34593 C.

NEW PROJECTS.

China.

Imperial Chinese Railways. A detailed history of the railway projects in China. 2300 w. Engng—June 1, 1900. No. 34810 A.

The Present Status of Railway Development in China. Abstract of article by M. G. Bouillard in *Revue Generale des Chemins de Fer.* Facts of interest concerning the constructed and projected railways. Map. 1800 w. Eng News—July 5, 1900. No. 35183.

"Gradient" Railway.

The Halford Gradient Railway. Brief illustrated description of a peculiar English railway, the invention of Mr. Halford. 500 w. Eng News—July 5, 1900. No. 35,181.

North Michigan.

The Copper Range R. R. in the North Michigan Peninsula. Illustrated account of a new railway opening a section of the Michigan copper regions which has not hitherto been worked, owing to lack of transportation facilities. 2700 w. Eng News—May 31, 1900. No. 34514.

Paris.

General Description of the Railway Line from Courcelles to the Champ de Mars which Crosses the Seine by Viaduct (Ligne de Courcelles au Champ-de-Mars, à Paris). A. Dumas. A general description of this new connecting line, partly in tunnel and partly on viaduct, very well illustrated. 5000 w. 1 plate. Génie Civil —June 2, 1900. No. 34753 D.

Railway Scheme.

The Cosmopolitan Railway. Harry C. Martin. Brief discussion of the scheme proposed by ex-Gov. Gilpin of Colorado, for uniting five continents by one system of railroad. 1200 w. Yale Sci M—June, 1900. No. 34620 C.

Scottish Railway.

The Invergarry and Fort Augustus Railway. Description and sketch map of an important new line in Scotland. 1500 w. Transport—June 8, 1900. No. 34875 A.

PERMANENT WAY AND FIXTURES.

Masonry.

Railroad Concrete Masonry. W. A. Rogers. Describes the qualities of concrete and the practice followed in its use by the writer. 3000 w. R R Gaz—June 15, 1900. Serial. 1st part. No. 34894.

Rails.

Rails and Rail Joints. Illustrated description of the types now in use. 1800 w. Sci Am Sup—June 9, 1900. No. 34681.

Round Houses.

Construction, Equipment and Ventilation of Round Houses. Committee report with illustrations. 2500 w. Cent Ry Club—May, 1900. No. 34839 C.

Shops.

See also Motive Power and Equipment, above.

New Shops and Yards of the Colorado & Southern Ry. Plans, sections and description of large shops being built in Denver, Colo. 2000 w. R R Gaz—June 15, 1900. No. 34892.

Signaling.

A System of Signaling for Railways. W. S. Boult. Abstract of a paper read before the Brit. Assn. for the Adv. of Science. Illustrates and describes an apparatus for fog signaling. 5500 w. Eng News—June 14, 1900. No. 34883.

Signals.

Tests of Railroad Signal Glass. Louis Derr. Extracts from a paper read before the New England R. R. Club. Gives the results of a series of rather severe tests. 1800 w. Ry & Engng Rev—June 30, 1900. No. 35131.

Switches.

Westinghouse Electro-Pneumatic Switch and Signal System at the Bishopsgate Station of the Great Eastern Railway (Elektrisch Gesteuertes Druckluft-Stellwerk, Bauart Westinghouse, Ausgeführt von der Great Eastern Eisenbahn). A well illustrated description of the plant, with some switch and signal details. 2200 w. Glaser's Annalen—June 1, 1900. No. 34748 D.

Track.

Pot Sleepers on the Great Indian Peninsula Ry. Illustrates the pattern now standard with this company and gives a brief account of past experience with these sleepers. 700 w. Ry & Engng Rev—June 9, 1900. No. 34698.

Track Improvements on German Railways. Information from an address by Prof. Goering. 1600 w. Ry & Engng Rev—June 9, 1900. No. 34699.

Tracklaying by Machinery on the Canadian Pacific Ry. Description of the work and the machine. 1700 w. Eng News—June 14, 1900. No. 34882.

TRAFFIC.

Brazil.

Railways in Brazil. Information collected from various sources concerning the history, operation, rates, regulations, etc., of the lines. 13800 w. U. S. Cons Repts, No. 758—June 18, 1900. No. 34871 D.

Statistics.

The Railroads of the World. Condensed table from the *Archiv für Eisenbahnwesen.* 400 w. R R Gaz—June 1, 1900. No. 34572.

STREET AND ELECTRIC TRAMWAYS

Berlin.

Electric Traction on the Berlin Metropolitan Railway. Translated from the *Elektrotechnische Zeitschrift*. Illustrates and describes the scheme proposed by the Union Elektricitäts Gesellschaft. 6700 w. Tram & Ry Wld—June 7, 1900. No. 35071 A.

The Introduction of Electric Power on the Great Berlin Street Railway up to the End of 1899 (Die Einführung des Elektrischen Betriebes auf der Grossen Berliner Strassenbahnen und Stand desselben Ende 1899). A general descriptive article on the Berlin street railway overhead trolley system, well illustrated. 3600 w. Zeitschr f Klein u Strassenbahnen—May 1, 16, 1900. Serial. 2 parts. No. 34704 each C.

Birmingham, Ala.

The Street Railway of Birmingham, Ala. Illustrated detailed description. 2200 w. St Ry Jour—June 2, 1900. No. 34566 D.

Budapest.

The Budapest-Budafaker Suburban Electric Railway (Die Budapest-Budafaker Elektrische Localbahn). J. v. Fischer and Dr. A. Brunn. A general description, with details of the construction and equipment of this trolley road to an outlying suburb. 2800 w. Zeitschr f Klein-u Strassenbahnen—May 16, 1900. No. 34707 C.

Cars.

Passenger Cars for Boston Elevated Railway. A. Richards. Illustrated description. 1000 w. R R Car Jour—June, 1900. No. 34825.

Cuba.

The First Cuban Electric Railway. Brief illustrated description of the line from Regla to Guanabacoa. 700 w. Elec Wld & Engr—June 2, 1900. No. 34558.

Ekaterinoslav.

Electric Railway Plant at Ekaterinoslav, South Russia (Elektrische Bahnanlage in Jekaterinoslaw). Messrs. Winkler and Orban. An illustrated description of a trolley road, power house, and details. 3200 w. Elektrotech Zeitschr—May 24, 1900. No. 34732 B.

Electrical Equipment.

The Electrical Equipment of the Waterloo and City Railway. Bernard Maxwell Jenkin. Read before the British Inst. of Civ. Engs. Illustrated detailed description. 3500 w. Prac Engr—June 15, 1900. Serial. 1st part. No. 35003 A.

Electrolysis.

Electrolysis from Facts and Figures. E. E. Brownell. Discusses the conditions under which most electric roads are now operated, the defective construction, etc. Illustrations and discussion. 3500 w. Jour N. E. Water Wks Assn—June, 1900. No. 34500 E.

Electrolysis in Gas and Water Mains. D. Irving. Read at Bristol meeting of the So. Dist. Assn. of Gas Engs. and Mgrs. Explains the Bristol method for its prevention. 1800 w. Jour Gas Lgt—June 5, 1900. No. 34835 A.

Engine Economy.

Economy of Simple or Compound Engines for Traction Work. W. H. Booth. A discussion of the advantages and disadvantages of the two types. 2200 w. Elec Rev, Lond—June 15, 1900. No. 35010 A.

Heavy Track.

Heavy Track Construction in New Orleans. Illustrates and describes probably the heaviest T-rail track construction ever laid for electric service in the United States. 1000 w. St Ry Jour—June 2, 1900. No. 34567 D.

Interurban.

The Indianapolis, Greenwood and Franklin Interurban. Cloyd Marshall. Map, illustrations, and description. 2000 w. St Ry Rev—June 15, 1900. No. 34931 C.

The Lexington and Boston Electric Railway. An illustrated account of an electric road following for a large part of its course close to the route made famous by Paul Revere's ride. 3000 w. St Ry Jour—June 2, 1900. No. 34565 D.

Ithaca, N. Y.

Car Tests at Ithaca, N. Y. E. L. West. Describes tests made to determine the condition of the line and behavior of the cars when in regular service. 2500 w. St Ry Rev—June 15, 1900. No. 34930 C.

The Street Railway System of Ithaca, N. Y. H. S. Cooper. An account of the road, the route, etc. 2500 w. St Ry Rev —June 15, 1900. No. 34929 C.

Light Railways.

British and Colonial Light Railways. Editorial discussion of the working of the British Light Railway Act. 3300 w. Engng—May 25, 1900. No. 34599 A.

Mono-Rail.

The Mono-Rail Suspended Railway of Barmen-Elberfeld. Full illustrated description of this novel railway, and the immense increase in speed that will be

possible. 2300 w. Tram & Ry Wld—May 10, 1900. No. 34503 A.

Moving Sidewalk.

The Moving Sidewalk at the Paris Exposition of 1900 (Die Rollende Trottoire der Weltausstellung von 1900). A general description, with two illustrations. 800 w. Zeitschr f Klein u Strassenbahnen—April 16, 1900. No. 34703 C.

The Moving Sidewalk at the Paris Exposition. Illustrated description, with comments on its success and method of operation. 3300 w. Elec Wld & Engr—June 30, 1900. No. 35125.

Nice.

Electric Tramways of Nice and of the Littoral. Illustrates and describes a transformed system, including the latest appliances for electric traction. 1500 w. Tram & Ry Wld—May 10, 1900. No. 34504 A.

Oberammergau.

The Murnau-Oberammergau Railroad. Illustrated description of a road made for the use of either steam or electricity. Also an account of the first performance of the passion play this season. 700 w. Sci Am Sup—June 2, 1900. No. 34508.

Power House.

See Electrical Engineering, Generating Stations.

Rapid Transit.

The New York Rapid Transit Road (Die Rapid Transit-Stadtbahn für New York). F. M. v. d. Werra. A good description, very well illustrated, of the road in general and various details of construction. Serial. 2 parts. 7500 w. Zeitschr d Ver Deutscher Ing—May 26, June 2, 1900. No. 34716 each D.

Rotary Currents.

Experiments with High Tension Rotary Currents for Electric Railways (Versuche über Verwendung des Hochgespannten Drehstromes für den Betrieb Elektrischen Bahnen). Walter Reichel. A full and well illustrated account of experiments made by the Siemens-Halske Co. with live voltages up to 10,000, transformed down to 750 on the electric locomotive. 6000 w. Elektrotech Zeitschr—June 7, 1900. No. 34737 B.

Safety Rules.

System of Safety Regulations for Electric Railway Plants (Entwurf zu Sicherheitsregeln für Elektrische Bahnanlagen). A preliminary plan of a committee of the Verband Deutscher Elektrotechniker, containing regulations for overhead trolley and accumulator roads, covering all parts of the plant. 1500 w. Elektrotech Zeitschr—May 10, 1900. No. 34723 B.

Service Problems.

Number of Cars Required on a Given Length of Track at Various Speeds and Headways. H. C. King. Diagram, graphically presenting all information pertaining to any required service. 400 w. Tram & Ry Wld—May 10, 1900. No. 34502 A.

Southampton.

Southampton Corporation Electric Tramways. Illustrated detailed description of the system. 2300 w. Tram & Ry Wld—May 10, 1900. No. 34501 A.

Southampton Corporation Tramways. Illustrates and describes interesting features of the line. 2500 w. Elec Engr, Lond—June 8, 1900. No. 34932 A.

Stray Currents.

Methods for Lessening the Danger of Stray Currents from Electric Tramways, Particularly the Kapp Method of Relieving the Rails of Current. (Ueber Methoden zur Verringerung der Gefahren Vagabundirender Ströme bei Elektrischen Bahnen, insbesondere die Kapp'sche Methode der Sahienenentlastung). Dr. J. Teichmüller. A description of the Kapp method of making the rails the neutral wire of a 3-wire system, with practical applications. 2000 w. Elektrotech Zeitschr—May 31, 1900. No. 34735 B.

Subways.

The Choice of an Operating System for City Subway Roads (Die Wahl des Betriebs-Systemes für Städtische Tiefbahnen). Gustav Schimpff and Wm. Kübler. A general review of the principal subway roads of the world, with table and illustrations. Serial. 1st part. 800 w. Deutsche Bauzeitung—May 5, 1900. No. 34701 B.

Sydney.

George and Harris Street (Sydney) Electric Tramway. Detailed description of the first electric line in Sydney. 2200 w. Engr, Lond—April 27, 1900. No. 34076 A.

Tramway Currents.

The Action of Electric Tramway Currents on Submarine Cables and Other Electric Circuits. Andrew Jamieson. An explanation of the causes of delay in the transmission of telegrams from Cape Town to England. Also discussion. Ill. 7500 w. Trans Inst of Engs & Shipbuilders in Scotland—Feb., March and April, 1900. 3 parts. No. 34326 each D.

Tri-phase.

The Tri-Phase Electric Cable Road on Mont Dore, France (Die mit Drei-phasen Strom Elektrisch Betriebene Seilbahn auf den Mont-Dore (Departement Puy-de-Dome) in Frankreich.) From an address by E. A. Ziffer before the Verein für die Förderung des Local-und Strassen-

bahwesens. A short description of this cable road, said to be the only one in Europe worked by tri-phase current. 400 w. Zeitschr für Klein-u Strassenbahnen—May 1, 1900. No. 34706 C.

Trolleys.

Some of the Principal Tvpes of the Over-Head Trolley. Spencer Baird Prentiss. Brief illustrated description of types comparatively little known. 1200 w. Elec Rev, N. Y.—June 27, 1900. No. 35128.

Underground.

Electric Traction on the Metropolitan District Railway. An illustrated description of what has been thus far accomplished. Also editorial. 3500 w. Elect'n, Lond—May 25, 1900. No. 34614 A.

Electric Underground Railway for New York, U. S. A. Illustrated detailed description of the plans as now adopted. 5000 w. Engr, Lond—April 27, 1900. No. 34072 A.

Zurich.

The Zürich Electric Street Railways (Die Elektrischen Strassenbahnen der Stadt Zürich). J. Sigfrid Edström. A well illustrated account of the different parts of this tramway system. 1500 w. Elektrotech Zeitschr—April 26, 1900. No. 34112 B.

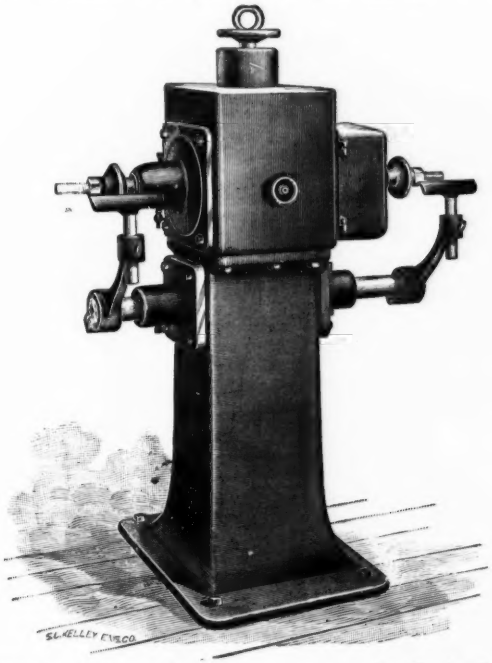
IMPROVED MACHINERY

New Processes and New Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Electric-Driven Grinder.

THE illustration herewith shows a multi-speed electric emery grinder, made by the Stow Manufacturing Company, Binghamton, N. Y. Two features about this machine are new: The periphery speed of the wheel can be kept constant from 16 inches in diameter down to 10 inches. The speed change can be made in the speed except by the foreman or other person entrusted with the key. Careless workmen, therefore, are prevented from tampering with the wheel, and perhaps, speeding it to the bursting point. Further details will be furnished by the manufacturers, who build this grinder in any size desired.



regulation is so sensitive that it can be controlled to the fraction of a revolution of the wheel, and as the wheel wears away the speed can be proportionately increased—not by an abrupt step from one cone to another, but just as desired, so that the wheel will cut to the best advantage on the one hand, and not reach the danger point on the other. A locking device is provided, so that no

Gas Engine Igniter.

THE advantage of the dynamo over batteries for igniting gas and gasoline engines is apparent. It is well known that the strength of a battery current on this class of work rapidly gives out, the battery soon becomes exhausted, requiring frequent renewals of solution and zinc. Besides this, trouble often arises through the battery

connections becoming corroded and opening the circuit. A properly constructed

dynamo, on the other hand, can be depended upon to give a constant current.

This machine is constructed with a permanent magnet field and an armature of the drum type, similar to that used in direct current motors.

It has self-feeding carbon brushes, and is self-lubricating, being provided with grease cups. This igniter is especially adapted for marine work, the armature, being enclosed, is dirt, oil and moisture proof. It can be run in either direction, and if fly wheel of engine runs true, may be driven from a friction pulley bearing upon same, or may be belted to the fly-wheel or any convenient shafting. The speed should be about 2 000, but it can be run at any speed, from 1,500 to 2,000 R. P. M.

Details of the igniter shown herewith will be furnished by the Holtzer-Cabot Electric Co., Brookline, Mass.

Outdoor Electric Lamps.

USERS of electric signs usually experience trouble during wet weather with short circuits in the bases of the incandescent lamps used. Signs are commonly made tight at the back, and as far as possible around the receptacle, but it has not been possible to secure an absolutely water-tight fit between the lamp and the receptacle. To overcome this difficulty, Mr. Chas. A. Chase, of Chicago, has devised an arrangement, the main feature of which is the enlargement or annular ring around the neck of a lamp bulb, as shown in the accompanying illustration. A rubber ring or gasket placed in front of this shoulder is compressed when the lamp is put in the receptacle, thus forming a tight joint between them. The electrical contacts of the lamps and the conducting portions of the socket are, therefore, protected from moisture.

While these lamps are intended especially for signs, they may be used to advantage in all outdoor work, as well as for industrial purposes, as in breweries and chemical works, where dampness or corroding gases make the use of electric lamps difficult.

Manufactured by the General Incandescent Lamp Co., 39-47 East Prospect

street, Cleveland, Ohio, who will furnish further information on request.